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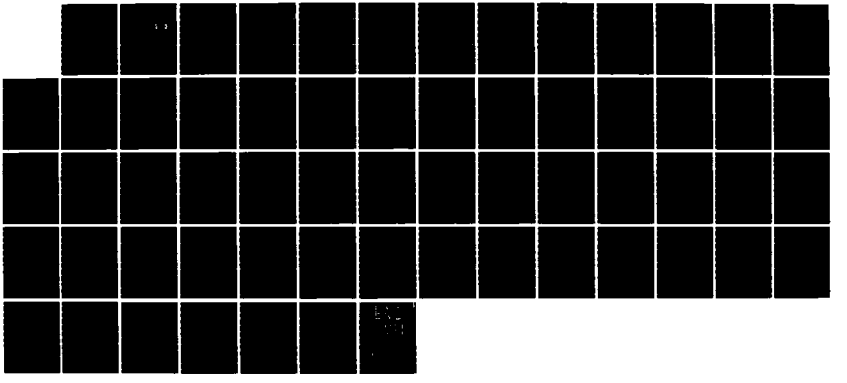

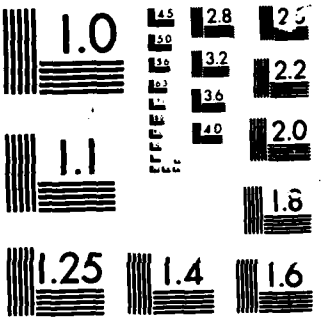

MICROCOPY CHART

DNA-TR-85-107

7912AD PROGRAMMABLE DIGITIZER EVALUATION

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Technical Report

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9	2		Tektronix 7912AD Programmable Digitizer
9	1		High Speed Digitizer Digital Oscilloscope
			7000-series Oscilloscope

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The 7912 is a microprocessor-based recording digital oscilloscope. The accompanying report details tests which were conducted as an evaluation of the 7912AD for use in underground nuclear testing, data accuracy, bandwidth, and susceptibility to electromagnetic pulses associated with UGT. Since electromagnetic interference may disrupt the power supply being used for the 7912AD, an evaluation of the machine with regard to brief power losses was conducted. Finally, a theoretical study was made of data recovery time and of the microprocessor-based control system in the 7912.

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18. SUBJECT TERMS (Continued)

EMI Evaluation of 7912AD Digitizer
GPIB Compatible Instrumentation

SUMMARY

The 7912AD Programmable Digitizer is a high speed storage oscilloscope with a microprocessor-based control system and both analog and digital outputs. In the investigation reported here, we are concerned with the factors that affect the instrument's suitability for recording data from underground testing experiments including the 7912AD's data accuracy, data recovery time, bandwidth, susceptibility to electromagnetic interference, and its programmable control microprocessors and firmware system.

To evaluate the 7912AD's data accuracy, a precision voltage source was used. It was found that the data accuracy of the 7912 was determined by the accuracy of the 7000-series plug-ins and, when they were within the calibration specifications, the 7912AD was as accurate as the instrument which was used as a reference - a Tektronix 7854 Oscilloscope.

The data recovery time is the sum of the scan and storage time, 16.4 ms, and the amount of time required to move the 8202 bytes of data out over the GPIB at 710 k bytes/sec, approximately 11.55 ms, for a total of almost 28 ms. These times are calculated or referenced rather than measured since the system controller determines the data recovery time. As with any device on an IEEE-488 bus, data moves at the rate of the slowest listener and therefore the 28 ms is a minimum possible time for data egress.

As was true for the data accuracy, the bandwidth of the 7912AD is primarily a function of the 7000-series plug-ins. With a calculation of bandwidth based on rise times, the 7912AD usually allows bandwidths to fall within their specifications. The highest bandwidth found was approximately 484 MHz for a combination of a 7A19 vertical plug-in and a 7B80 horizontal plug-in; the specifications for the 7A19 claim a bandwidth of 500 MHz.

The primary interest in this investigation of the 7912AD was of electromagnetic interference susceptibility. It was found that the 7912AD could withstand a 1400 volt, 28 amp pulse across its chassis from front to rear panels applied with a Spire SPI-25 Pulser. The GPIB line and power line also proved resistant to any pulse that the SPI-25 Pulser could generate. (These lines were not driven directly so they were not exposed to the same amount of power as the chassis itself.)

Since the 7912AD is microprocessor-based, it depends upon a 6800 microprocessor to interpret commands which are sent to it and a 2900 bit-slice microprocessor for memory management, it was feared that a brief power loss might upset the operation of the microprocessors. However, measurements revealed that , even with a power loss of 100 ms, no system malfunctions occured. In the statement of work, it was proposed that the possibility of eliminating the microprocessors be considered. Since these microprocessors control nearly every facet of the 7912AD, to eliminate them would require a complete redesign and be a step backwards in terms of capability. Although a series of programmable plug-ins is available from Tektronix, they were not evaluated since they are offered in a limited bandwidth; it was felt that the programmable plug-ins were not likely to be used in underground testing.

In order to protect the system controller during testing, it was necessary to disconnect the 7912AD from the controller. When this is done, however, the 7912AD enters the local mode and loses it programmed settings. Several designs were considered to alleviate this problem and the final design, a TTL level open-collector driver on the Remote Enable line of the GPIB, functioned well.

In the past, Tektronix has offered a high-speed digitizing option which allows the 7912AD to digitize and store a waveform in 4.5 ms rather than the standard 16.4 ms. While this results in a loss in resolution due to the compression technique which is used, it offers an appreciable decrease in data egress time. Tektronix is not offering this option currently but may be willing to offer it if a sufficient number of 7912ADs is involved.

The following recommendations are made with regard to 7912AD operating procedures and arrangements:

1) The 7912AD should be allowed its recommended 20 minute warm-up time.
2) Non-programmable plug-ins should be used.
3) No attempt should be made to override or replace the microprocessor system.
4) Talk to Tektronix concerning the availability of a high-speed digitizing option (7912AD Option #4).

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SECTION 1
INTRODUCTION

The 7912 Programmable Digitizer is a storage oscilloscope with a microprocessor based control system which is able to scan and then digitize the acquired waveform at a very rapid rate by utilizing a scan converter tube containing a semiconductor target. The writing electron gun scans the target, a diode matrix, and wherever the electron beam strikes it turns on a diode in the matrix. The reading gun then searches for points where current flows and outputs these points as data. In TV mode, the grid is scanned in the manner of a TV screen and the results of this scan are then output to a monitor. In digital mode, the target is sequentially scanned by column and then by row to provide pointers with which to interpret the data. The 7912AD is rather similiar to the 7912R, the principal advantage of the 7912AD being its microprocessor-based control system. This control system, as is illustrated by Figure 1, monitors the GPIB, General Purpose Interface Bus, for commands which are sent in ASCII and then uses the 6800 microprocessor to interpret and execute the commands.

The GPIB, or IEEE-488, is a communications interface for use between a computer, the system controller, and associated test equipment. The GPIB allows a system controller computer to command test equipment and then to gather data from the test equipment. In a system under the control of a system controller, the test equipment is in its "REMOTE" mode and when the equipment is being controlled by its front panel controls, it is designated as being in its "LOCAL" mode. The 6800 based control system either directly or indirectly controls the plug-in interface (both the vertical and horizontal plug-ins are Tektronix 7000-series oscilloscope plug-ins), the IEEE-488 interface, all of the 7912AD's programmable settings, and, of course, the 2900 bit-slice microprocessor which is used for memory control and to send data over the GPIB. The 2900 bit-slice microprocessor is used for memory control since it is much faster than the 6800 microprocessor, but it cannot be used for any more than this because it is very limited in capability.

Factors to be taken under consideration in this study are currents which would be induced on the chassis, power lines, and GPIB control lines as well as a possible power interruption. Temperature and physical shock are not test conditions for the 7912AD since, ideally, all of the data should be out of the 7912AD and into the portal recording station before the ground shock arrives at the 7912's location.

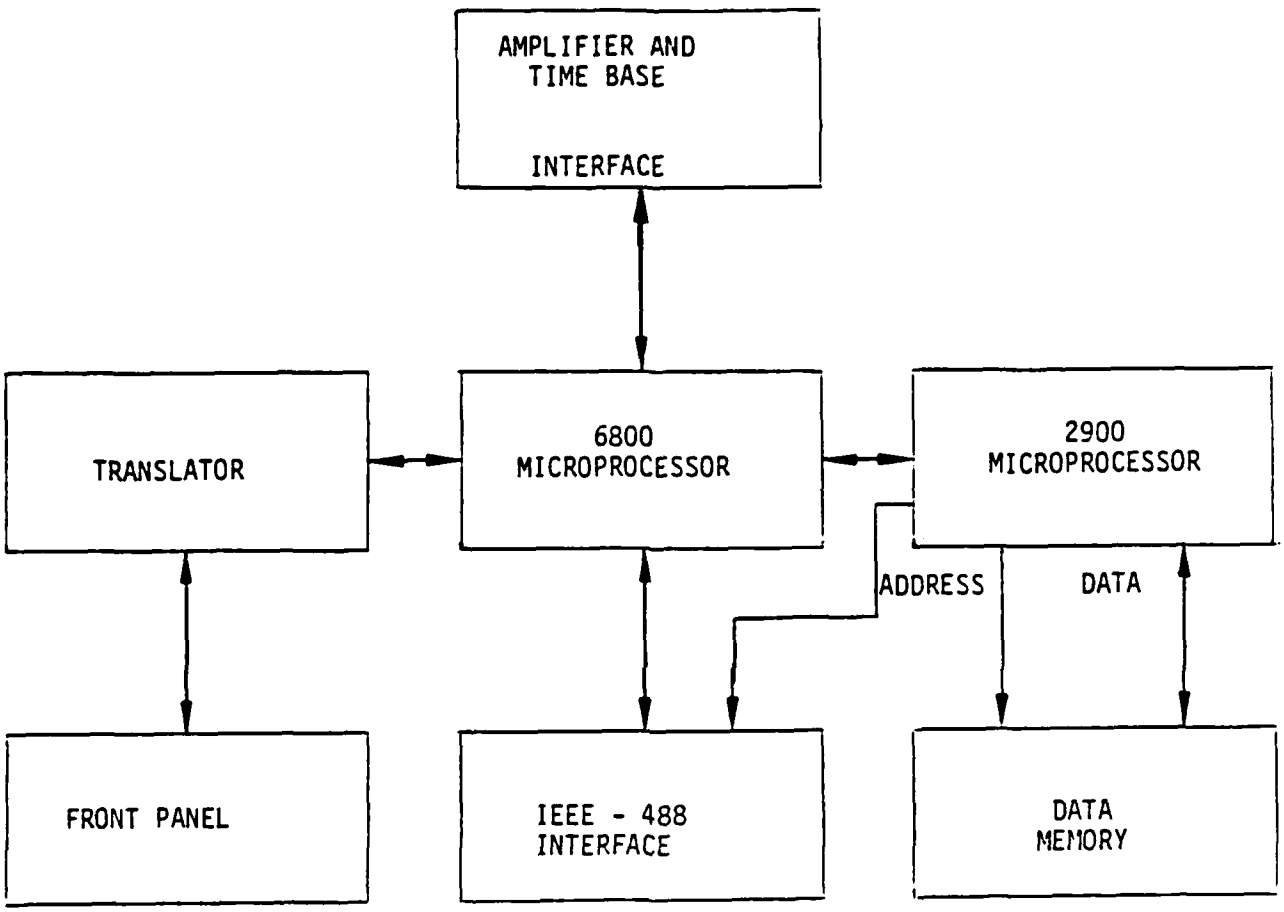


Figure 1. 7912AD microprocessor system

SECTION 2
DISCUSSION OF METHODS USED AND RESULTS OBTAINED

This evaluation of the suitability of the 7912AD for underground testing can be divided into four areas. The first of these areas is concerned with familiarity with the 7912 operation and circuitry as well as conducting operational tests to establish operating requirements. The next basis for evaluation is one concerning the data accuracy, data recovery time, and bandwidth of the 7912AD. The third of these areas, and the most important, consists of evaluating the 7912AD's susceptibility to electromagnetic interference through various ports of entry into the machine. The fourth area is an evaluation of the 7912AD's programmable control microprocessors and firmware system in terms of the best method for utilizing or eliminating the microprocessors in order to assure maximum reliability during underground nuclear testing.

2.1 7912 OPERATION

First of these four areas of investigation involved familiarization with the 7912 and its operating requirements. The 7912AD is, as was described in the introduction, basically a digital oscilloscope. It requires the same conditions for operation as a conventional oscilloscope including a properly adjusted trigger level. The 7912, however, requires a more precisely adjusted trigger level than do conventional oscilloscopes and therein lies a problem. Even though the "tiggered" indicator may light and a waveform be present in the TV mode, the 7912 may not be triggered properly in the digital mode, which results in setting the pointers for the raw data array to zero. Without these pointers, the data is meaningless. The best triggering results appear to be with the trigger level just barely in the triggered region. Also, an error condition for the 7912 sometimes occurs depending upon the physical location of the waveform on the diode matrix. The 7912 does not allow for more than five values to be found on the same vertical line; two values are required for the top and the bottom of the trace and two more values may be required for the top and the bottom of a defect in the diode matrix. (A defect in the diode matrix is a point that is read as data regardless of whether or not there is actually any data at that point and the specifications for the 7912 specify that no more than one defect is allowed per vertical line.) The 7912 periodically detected

more than five values in the same vertical line but a repositioning of the waveform on the screen caused this problem to disappear.

The 7912 has another operating requirement which must be met and which can be a problem depending upon the way in which the 7912AD is controlled. For electromagnetic interference testing in the laboratory, it was desired that the 7912AD be electrically isolated from its system controller in order to protect the system controller. In order to accomplish this protection, the GPIB connector was physically removed from the 7912AD with the immediate result of sending the 7912 into local mode; the programmed settings of the 7912 were completely lost. If the 7912AD is being used in a configuration such that the intensity level and other settings are being set by the system controller, then it is important that the 7912 not be allowed to enter the local mode as these settings will be lost. If the 7912 were to enter the local mode during a scan, the settings could change and the waveform might be distorted. After the IEEE-488 standard was reviewed and all of the GPIB lines were monitored both before and after the disconnection of the 7912 from the GPIB line, it was concluded that holding the remote enable line low would result in the 7912 remaining in local mode. In order to protect the 7912 from a current surge in case it attempted to alter the REN line's state, a current limiting resistor was used to pull the REN line low. An 820 ohm resistor placed between the REN line and the logic ground on the GPIB line resulted in holding the 7912 in local mode when it was disconnected from the system controller. Once any interference was applied, however, the 7912 reverted to local mode and lost the values of its programmed settings. A pulse of just a few volts anywhere on the chassis was enough to promote this mode change. A reduction in the resistors value made the REN line's state more stable and the 7912 was now resistant to pulses of up to 35 volts. A further reduction to 560 ohms made the 7912 stable all the way up to 1 kV and, at this point, the resistor was replaced with an open-collector TTL driver.

Since the 7912AD digitizes its input by causing an electron beam to scan a semiconductor matrix, it is possible for the delicate semiconductor matrix to be permanently damaged if care is not taken to limit the intensity of the electron beam.

The only other operating requirement, besides those of a conventional oscilloscope, is that, for remote control applications, a system controller be utilized. The controller which was used by JAYCOR is a Hewlett Packard 9816 Computer which was programmed in HP's basic. Appendix B contains a listing of the program which was used for the 7912's evaluation.

2.2 ACCURACY, RECOVERY TIME, AND BANDWIDTH

In order to evaluate data accuracy, a precision voltage source was used. The Tektronix 7854 Oscilloscope includes a precision voltage source which was utilized to evaluate the 7912AD and several sets of 7000-series plug-ins. With the Tektronix 7854 as a reference in which the plug-ins could also be used, the 7912 was used to measure the precision output voltage of the 7854 and it was found that the 7854 and 7912 were in agreement with one another as long as the same plug-in set was being used in each of the instruments. The main factors which determined the data accuracy were the plug-in horizontal and vertical sections. The 7912 can only be as accurate as the plug-ins being used and, as long as the plug-ins used were properly calibrated, the 7912 was as accurate as readings would permit. No degradation of data accuracy was observed as a result of pulsing the 7912AD.

Data recovery time in a GPIB system is a function of the reception rate of the slowest listener on the bus. Due to the relatively slow data transfer rate of JAYCOR's system controller, 110 k bytes/sec, the maximum transfer capability of the 7912 for data egress could not be measured. However, the Tektronix specifications claim a scan time of 16.4 ms and a data transfer rate of 710 k bytes/sec. For the 8202 bytes which are required to convey the delimeters, pointers, and data values in a "DUMP RAW" command, approximately 11.55 ms are required at the 710 k bytes/sec data transfer rate. This brings the minimum amount of time required for data egress to just under 28 ms. If the HP 9816 were used as the system controller this data egress time would be approximately 94 ms due to the relatively slow data transfer rate of that computer. Of course, data egress time is also dependent upon the time required for the data to reach the system controller. While a system could be employed to convert the GPIB lines which come out of the 7912 into a bi-directional fiber optic link for communications between the 7912 and the system controller, JAYCOR has a better suggestion. The 7912 may be used in local mode during the actual testing and directed to execute a service request once the data is gathered. A controller could be constructed which would detect this service request, send the "DUMP RAW" command to the 7912, and then convert the data which comes out of the 7912 into a BIΦ-L format suitable for transmission over a fiber optic cable to the portal recording station. In this manner, the data could be removed from the 7912 much faster because the device could be constructed to handle the fastest data rate that the 7912 is capable of and the distance between the 7912 and

this device would be less than the distance between the 7912 and the system controller. The distance between the 7912 and the controller is important in a GPIB system because the GPIB line employs a hand-shake data transfer technique; i.e. once data is sent, the system waits for a reply that the data was received before sending more data.

The evaluation of the bandwidth of the 7912AD is dependent upon, as was the data accuracy, the 7000-series plug-ins. For several sets of plug-ins, bandwidths were calculated using measured rise times; the product of bandwidth and rise time is approximately a constant of 0.35. The bandwidth was found, as was expected, to be a function of the amplifier being used and was usually within the amplifier's specifications. The highest bandwidth found, and the only bandwidth which did not fall within the plug-in's specifications, was one of approximately 484 MHz. JAYCOR's stock of Tektronix 7000-series plug-ins was limited to an upper bandwidth of 500 MHz, a 7A19 with a literature bandwidth of 500 MHz, but there is a one GHz plug-in available from Tektronix, the 7A21. The reason that no programmable plug-ins were tested is that they are restricted to a bandwidth of 200 MHz according to Table 1-2, 7912AD System Electrical Characteristics, of the 7912AD Programmable Digitizer Operator's Manual.

2.3 CURRENT INJECTION TESTS

In order to evaluate the 7912AD's susceptibility to electromagnetic interference, pulse injection tests were made on the power lines, GPIB cables, and directly onto the chassis of the 7912AD. A related problem is a possible power loss due to electromagnetic interference on the main power system; this subject was also investigated. The accompanying computer print-outs and plots (please refer to Appendix C) are referenced by shot number and indicate the 'status of' and the 'data in' the 7912AD before and after it is subjected to electromagnetic interference. These values are compared with each other to determine if the interference altered any of the settings of the 7912, the data in the 7912, or the operability of the 7912. The computer printouts and plots for these tests are in Appendix C.

For the 3000 test series, the output of the Spire SPI-25 Pulser was capacitively coupled to the power line of the 7912AD as indicated by Figure 2. The second test conducted in this series, shot number 3001, shows a typical test output. The top section of the printout indicates that the pulser voltage was set at 750 volts and identifies the Ailtech current probe. The 'before' and 'after' values are for the programmable and non-programmable settings of the 7912ADs both before and after the pulse injection.

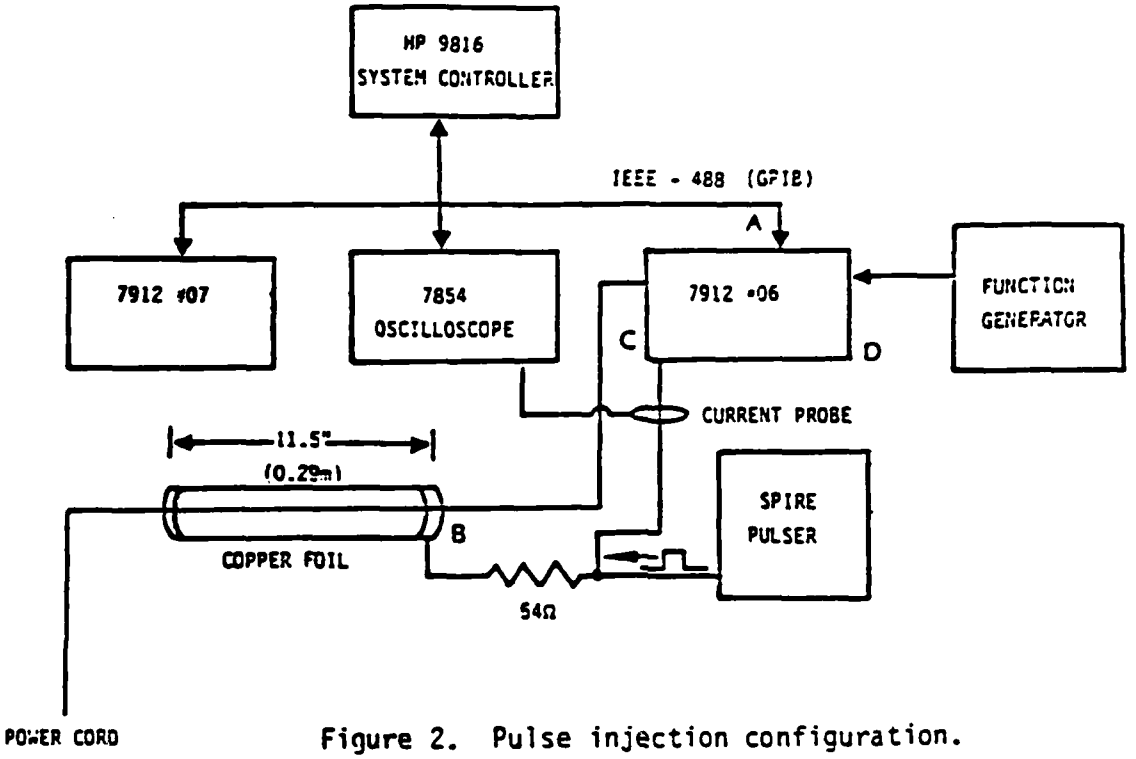


Figure 2. Pulse injection configuration.

SERIES:	PULSE INJECTION BETWEEN POINTS:
2000	A, C GPIB cable shield to chassis
3000	B, C Capacitive coupling on power lines to chasis
4000	Does not apply, no pulse injection was used but instead the power supply was interrupted by the circuit shown in Appendix D
5000	C, D Chassis to chassis

The 7912 unit #06 was the unit which digitized an actual input and the unit to which the electromagnetic interference was applied. 7912 unit #07 was to be used for reference in case the settings changed for #06 and not for #07. The change in unit #07 from DIGITAL MODE to TV MODE is the result of a five minute timeout routine in the GPIB system controller; unit #06 did not respond to this change because it was off the GPIB when the command was sent. The main intensity levels are slightly different for the two 7912s due to slight differences in their electrical characteristics. Brief descriptions of the mneumonics for the remainder of the settings may be found in Appendix A. The next portion of the printout contains pointers and the byte count of the data sent when a "DUMP RAW" command is sent which are used to help reconstruct the digitized waveform. The final lines of the printout are of the differences between the values stored in the data memory of the 7912 before and after the electromagnetic interference has been applied. These differences will always be equal to zero unless the data memory in the 7912 is altered by the interference. The accompanying plot is of the top and the bottom edges of the data values. The rest of the series of injection tests upon the power line are similiar to this one with the exception that the voltage is being increased so that more current will be induced onto the power line. The last in this series, shot number 3004, uses an 11.5 inch strip of copper foil to induce a 12.8A spike onto the power line. As is illustrated by the printout for this shot, there is no loss of data or settings or even a change to the local mode due to the 12.8 amp pulse on the power line.

The next application of pulse injection was conducted on the GPIB cable. In order to introduce current into the GPIB line, the insulation was removed from a small section two feet away from the 7912 and the braid of the cable was driven directly by a high voltage pulser. This set of tests, the 2000 series, starts with a current of 1.3 amps between the braid and the chassis and goes all the way up to the limit of the Spire Pulser, 21.8 amps. Pulse duration is slightly less than 10 ns. In this range, there is no apparent damage or interference to the 7912AD. The measured resistance to interference is higher than expected since a 22 amp current pulse represents approximately 1000 times the amount of current normally carried on a line in the GPIB cable. Two representative printouts are provided for reference; shot number 2000 is of the 1.3 amp current pulse and shot number 2006 illustrates the resistance of the 7912AD to a 21.8 amp current spike.

The next application of electromagnetic interference was to pulse the chassis. In shots of series 900, 1000, and shot number 5000, attempts were made to upset the 7912

with voltage applied between various points on its chassis. These attempts stem from the fact that the shots prior to the 900 series were unsuccessful because, with an improperly terminated GPIB line, the 7912 was upset with voltages as low as one volt applied to its chassis. Once this REN line on the GPIB cable was properly driven, however, attempts made with pulses as large as 1400 volts, the Spire Pulser's upper voltage limit, were unable to disrupt the 7912. Shot number 5000, for example, has a voltage spike applied between the front and rear panels of the 7912AD through a 54 ohm resistor. The current in this shot was found to be 28.8 amps, nearly six times the current consumption of the 7912, and no disruption of the 7912 was detected.

In order to evaluate the capability of the 7912AD to withstand a pulse during a digitize operation, the following test was used. A TEK-109 Pulser was connected between the front and rear panels of the 7912 through a delay line of approximately 50 ns. A tap was connected to the output of the pulser in order to furnish a lower voltage pulse which would slightly precede the primary pulse. The pulse from the tap was used as a trigger for the 7912 which was configured to digitize a 10 MHz sinewave input. A single pulse was applied by the TEK-109 and the waveform which was digitized was displayed on a monitor and examined for errors. With a 300 volt pulse, the upper limit of the TEK-109 Pulser, there were no errors observed in the waveform.

Although the final type of testing conducted in this group of tests does not deal directly with applying electromagnetic interference, it is a simulation of what could occur if any interference were to momentarily disrupt the power supply of the 7912. For this series of tests, the 4000 series, a device was constructed which interrupts the power supply for a short period of time. A circuit schematic and description can be found in Appendix D. The power interruption is especially important in a microprocessor-based system because a single instruction lost could disrupt the entire system, and millions of instructions are executed per second. The 7912AD was, however, found to be well protected against a momentary power loss. Power interruptions ranging from 50 microseconds to 100 milliseconds in duration were unable to disrupt either the microprocessors or the data memory of the 7912. Although the Tektronix literature claims that the 7912 can survive a power interruption of 10 ms, JAYCOR found no problems with a 100 ms power interruption. This resistance to power interruption is probably due to internal capacitance in the 7912 power supply which is used to stabilize the voltage level. An interruption in the power supply is also important because the 7912 depends upon the state of a flip-flop for power. If power is interrupted to the 7912 for a sufficient amount of time, then the 'power flip-flop' changes its state and the 7912 does

not come back on once power is restored. In order to be able to restore power to the 7912 from a remote location, a TTL level signal must be applied to the 7912's actuate input.

2.4 MICROPROCESSOR UTILIZATION

The fourth part of the evaluation is to determine the best method of utilizing or eliminating the microprocessors and associated firmware system to improve reliability. The 7912AD does not use its microprocessors for minor tasks. The 6800 microprocessor is used to interpret commands from the system controller and to control the intensity level to the electron gun, even when in local mode, and the 2900 bit-slice microprocessor is used for memory management. With very few exceptions, every aspect of the 7912AD is under control of either one or both of the microprocessors and eliminating them would require a complete redesign of the 7912AD; in fact, eliminating the microprocessors would be a step back to the earlier non-microprocessor controlled version of the 7912AD.

In terms of the best utilization of the firmware systems, JAYCOR's first suggestion is to dump the raw data into the portal recording station rather than directing the 7912AD to process it. The 7912AD has the capability of limited processing of the data in order to reduce the burden on the system controller but, of course, this processing requires time which the 7912AD may not have; this additional amount of time may allow for ground shock to reach the location of the 7912 and all of the data could be lost. If the raw data is taken from the 7912 by a device which the 7912 treats as a system controller but is actually merely a "black box" which then transmits the data over a uni-directional fiber optic link to the portal recording station, then the data will be out of the tunnel much faster than otherwise possible. Such a device would allow the data to be removed from the tunnel very rapidly but could be buffered on the other end to allow the data to be fed into a computer at a rate that the computer could comprehend.

SECTION 3
CONCLUSIONS

Conclusions reached regarding the 7912AD are divided into sections concerning the operation and operating requirements, the 7912AD's performance characteristics, its resistance to electromagnetic interference, and the microprocessor-based control system and firmware of the 7912AD.

3.1 OPERATION AND OPERATING REQUIREMENTS

Operations with regard to the oscilloscope aspects of the 7912AD, as with any oscilloscope, require that an appropriate intensity level be set as well as the triggering level and appropriate ranges for the vertical and horizontal sections. The main differences here are that an improperly set intensity level can easily burn out the diode matrix and that the trigger level on the 7912 is exceptionally difficult to set. (If the trigger level is out of adjustment, then the pointers with which to interpret the data will be set to zero.) The operation of the 7912 also requires a familiarity with the GPIB which may be provided by the IEEE-488 Standard, a knowledge of the commands required for operating the 7912 in remote mode if that method of operation is desired, and a system controller or computer to receive and interpret the data.

While the 7912AD can be operated rather easily as a conventional oscilloscope in TV MODE, operation in DIGITAL REMOTE MODE is more complex. First, a control program must be written. This program must have the capability of addressing individual devices on the GPIB line, commanding and interrogating these devices, and the ability to reorganize the data output by the 7912 into a useable format. Care must also be taken to set the triggering level and to not exceed the intensity level which is safe for the particular 7912 being used while under remote control. Incidently, there is no standard value for maximum safe intensity level since the amount of energy which is transferred to the grid is also dependent upon the sweep speed and the input waveform.

3.2 PERFORMANCE CHARACTERISTICS

Conclusions reached concerning the performance characteristics of the 7912AD such as the data accuracy, data recovery time, and bandwidth reflect the fact that the 7912 is one of the 7000-series oscilloscopes with plug-ins for the vertical amplifier and

the horizontal time base. The data accuracy and the bandwidth are primarily functions of the 7000-series plug-ins rather than of the 7912 itself since an appropriate bandwidth may be selected by choosing a plug-in which is designed for the desired bandwidth and the data accuracy is dependent upon the calibration of the vertical amplifier. The data recovery time, however, is dependent upon the 7912AD itself and the system controller which is used. The minimum amount of time required for data egress is approximately 28 ms. For this to be the actual time required for data egress, the system controller must be capable of reading in data at 710 k bytes/sec, assuming there is no propagation delay between the 7912 and the system controller. As very few systems can manage this, the actual time required will be a function of the system controller which is used and the delay between the 7912 and the system controller unless the previously described communications device is used. This device would take data from the 7912's GPIB connector as quickly as the 7912 was capable of transmitting data and then retransmit this data to the portal recording station over a fiber optic link.

3.3 ELECTROMAGNETIC INTERFERENCE

The conclusions reached regarding the resistance of the 7912AD to electromagnetic interference were rather surprising. The 7912 was found to be unaffected by a 12.8 amp pulse induced into its power supply, a 21.8 amp pulse injected into its GPIB cable shield (not the internal lines themselves!), and a 28.8 amp pulse which was driven between the front and rear panels. These values are not upset values but actually the limits of the Spire Pulser which was used.

In other words, the 7912AD is highly resistant to electromagnetic interference at all of the connections which were tested. Since the 7912 was also unaffected by a power interruption of slightly over 100 ms, it can also be concluded that a successful attempt has been made to stabilize the 7912AD's power circuitry. Since, with an appropriate system controller or the device previously described, the 7912AD can scan and unload its data in under 50 ms, an interruption of the main power supply should not be a problem. (The only foreseeable problem is if the scanning of the grid which requires 16.4 ms is not completed before power is interrupted since the electron gun requires far more power than the semiconductors and is therefore more difficult to stabilize. The 100 ms of power-interruption with continued operation applies only to the semiconductors and not to the electron gun or any of the rest of the associated circuitry.) If the power in the tunnel should fail after the tunnel has been evacuated but before the actual test, the

7912 will go off and not come back on without being turned on from its front panel. The GPIB system controller cannot turn the 7912 back on but, if this capability is desired, a TTL level signal which is applied at the ACTUATE input can restore the 7912AD to the "ON" condition; the 7912 would then remain in the local mode until addressed by a system controller. This remote control of the 7912's power may also be used as a master reset for the 7912 if some sort of lockup should occur, such as the previously described positioning problem, before the event by merely turning the 7912 off and then back on. It should be noted, however, that such an operation will result in the 7912 losing any programmed settings which would then have to be reprogrammed.

3.4 MICROPROCESSORS AND FIRMWARE

The fourth and final group of conclusions concerns the research done on the 7912AD's microprocessor-based control system and its firmware system. From this research, it can be concluded that the 7912AD is so dependent upon its microprocessors that to eliminate them would require for the 7912 to be completely redesigned. Also, while the 7912AD has the capability of data processing, its use is not recommended as it requires a delay in data egress which can be avoided by merely allowing the computer in the portal recording station to process the data.

SECTION 4
RECOMMENDATIONS

Results of the tests and research conducted on the 7912AD Programmable Digitizers suggest several recommendations which concern the basic operation of the 7912AD, the resistance of the 7912 to electromagnetic interference, and its microprocessor-based control system.

4.1 BASIC OPERATION

Recomendations concerning the basic operation of the 7912 can be broken into two subsections. The first of these subsections concerns the oscilloscope characteristics of the 7912AD including data accuracy and bandwidth. In order to properly gather data in an underground test environment, it will be necessary to first calibrate the 7000-series plug-ins which will be used. It will also be necessary to use a horizontal time base which is fast enough to handle the data required. Due to the increased bandwidth of the non-programmable amplifiers, it is recommended that a set of non-programmable plug-ins be used. It is also recommended that an attempt be made to preset the trigger level to ensure proper triggering of the 7912.

Further recommendations concern the GPIB and the system controller. In order to remove the data as quickly as possible, it is necessary for the system controller to be able to read the data as quickly as possible, up to 710 k bytes/sec, since the 7912AD cannot transfer data any faster, and for the GPIB to be able to transfer data as quickly as is possible. Rather than actually connecting the system controller and the 7912ADs with a GPIB line, it is recommended that the GPIB connector on the 7912 be fed into a device which detects that data is ready, instructs the 7912 to begin transmitting data, and then relays the data out of the tunnel into a computer in the portal recording station over a fiber optic cable. If this approach is not used, and if an attempt is made to replace the GPIB cable between the 7912s and the system controller with a bi-directional fiber optic link, care should be taken to confirm that the drivers on the ends of the fiber optic link are capable of supplying sufficient current to hold the lines in determinate states. If these drivers are not capable of supplying sufficient current, then indeterminate states will occur on the GPIB lines as they did in the lab when the lines were improperly driven and the operation of the 7912 will become unstable.

4.2 ELECTROMAGNETIC INTERFERENCE

The 7912AD proved remarkably resistant to electromagnetic interference. Once the GPIB lines were properly driven (see Section 2), the 7912AD was unaffected by either the Spire Pulser or by brief power interruptions. Since no 7912AD upsets occured within the range of the Spire Pulser, 1400V at up to 28A, the only recommendations to be made concerning electromagnetic interference are to physically shield the 7912AD such that induced currents will be less than those experimentally applied. The equipment appears to be safe if shielded such that the power cable surge is less than approximately 10 amperes, the GPIB line transient less than 20 amperes, and shield the chassis sufficiently well to prevent the current from exceeding 30 amps. Since no electromagnetic interference testing was conducted on any of the 7000-series programmable plug-ins, their bandwidth is so restrictive that it seemed unlikely that they would be used for underground testing, it is recommended that programmable plug-ins such as the 7B90P not be used.

4.3 MICROPROCESSOR-BASED CONTROL SYSTEM

The final division of these recommendations regards the 7912AD's microprocessor-based control system and the accompanying firmware. Since the most electronically sensitive part of the 7912AD is probably the microprocessor and its support circuitry, it should receive as much protection as practical. The electromagnetic interference tests which were conducted, however, were unable to disrupt the operation of the microprocessor control system. Although the 7912AD is able to do limited processing of data such as signal averaging to reduce the processing load on the system controller, this processing is not recommended. The command 'DUMP RAW' will dump the unprocessed data to the system controller which can then analyze the data itself. In this manner, not only will more data be available for analysis, but the data will be out of the 7912AD before ground shock can reach its location. It is also recommended that, for an actual underground test, the 7912 be operated in local mode and a device constructed which has the capability to detect when the 7912 is ready to unload its data, to send the 7912 a 'DUMP RAW' command, and then to receive the data from the 7912 and transmit the data into the portal recording station via a fiber optic cable. In conclusion, it is recommended that DNA consider asking Tektronix to modify the 7912ADs for high-speed digitizing as this will allow the data to be out of the 7912s approximately 12 ms sooner.

APPENDIX A
GLOSSARY OF TERMS

DEF OFF	Reset Defect Flags
EMI	Electromagnetic Interference
FOC	Focus Level
GPIB	General Purpose Interface Bus
GRAT OFF	Graticule Only Mode is Off
GRI	Grid Intensity Level
HS1	Horizontal Channel 1 Scale Factor
HU1	Horizontal Channel 1 Units
ID	Identity of Instrument
MAI	Main Intensity Level
MODE DIG	Digital Mode
MODE TV	TV Mode
OPC OFF	Do Not Assert a Service Request When Completed
REM OFF	Do Not Assert a Service Request When Remote is Pressed
SSW DIS	Single Sweep Mode Disarmed
SSW NSS	Single Sweep Mode Not Selected
TV ON	Television Scale Factors On
VS1	Vertical Channel 1 Scale Factors
VU1	Vertical Channel 1 Units
XYZ	XYZ Outputs for External Oscilloscope Monitor

APPENDIX B
PROGRAM LISTING AND EXPLANATION

The accompanying program commands the 7912ADs, checks to see if those commands were obeyed, reads data from one of the 7912ADs, pauses for electromagnetic interference to be applied to the 7912AD, and then reads the settings and data to see if they were altered.

Lines 10 - 201 are merely used to dimension the variables used and to establish a set of commands which will be sent to the 7912ADs. Lines 210 - 271 are used to establish addresses for the devices on the GPIB. The next section, through line 2140, is used to send the commands mentioned earlier to the 7912ADs and to record their responses. The following section, through 2335, reads and stores data from one of the 7912ADs and section 2387 - 2431 reorganizes this data into a useable format. Menu 3 is used to print messages on the printout. The computer is then removed from the GPIB for EMI to be applied. The 5000 - 5198 block reads the data and settings again, and the following block reorganizes the data with the use of the pointers as was done in 2387 - 2431. The 6000 series of statements compares the 'before' and 'after' values to search for any discrepencies, errors, and the remainder of the program prints the before and after settings as well as any errors and a plot of the top and bottom edges of the waveform which is being used for reference.

```
10      !PROGRAM:  7912 HP-IB TEST
11      !
12      !-------------------------------------------------------------------------
20 Initializing:      !SECTION
21      !-------------------------------------------------------------------------
30      PRINT CHR$(12)  !CLEAR SCREEN
40      SEND 7;CMD 20
50      OPTION BASE 1
52      DIM A$[200],Io$(50)[25],I7$(50)[25]
62      DIM Ident 6$[40],Ident 7$[40],Comments$[100]
63      DIM B(4096),Y val(5,512),Seq v(3585)
64      DIM C(4096),Y val2(5,512),Seq v2(3585),Test(550)
65      DIM Gra ns1$[20],Dim hs1$[20]
67      COM /Int/ Q$(50)[25],P$(4,50)[25],Num ques,X,Y
68      COM /Bus/ Dev array(1:15),INTEGER Num dev,Status byte(1:15)
69      DIM Box$[1]
70      Clear$=CHR$(255)&CHR$(75)  !EXECUTES A CLEAR SCREEN
71      Flag1$="PRINT"          !THE STRING "PRINT" GETS A HARD COPY
72      GRAPHICS OFF
73      ON TIMEOUT 7,.5 GOTO 76
75      OUTPUT PRT;CHR$(27);"1";CHR$(5);  !SETS PRINT OVER 5 SPACES
76      OFF TIMEOUT
77      ! DEFINITIONS
80          ! Io = THE MATRIX WITH THE 7912 COMMANDS FOR LOGICAL UNIT 06
90          ! I7 = THE MATRIX WHTH THE 7912 COMMANDS FOR LOGICAL UNIT 07
100         ! P$(1)= THE MATRIX OF PRESET 7912 SETTINGS FOR LU 06
110         ! P$(2)= THE MATRIX OF RECORDED 7912 SETTINGS FOR LU 06
120         ! P$(3)= THE MATRIX OF PRESET 7912 SETTINGS FOR LU 07
130         ! P$(4)= THE MATRIX OF RECORDED 7912 SETTINGS FOR LU 07
140         ! Q$(N)= THE MATRIX OF QUESTIONS ASKED THE 7912--IN DATA QUES
141         ! C(N) = THE 7912 RAW DATA BEFORE TEST
143         ! B(N) = THE 7912 RAW DATA AFTER TEST
144         ! Seq v= THE SEQUENTIAL Y SETTINGS (IE:REORDERED Y FROM MATRIX B)
145         ! Y val(1,512)=TOP EDGE OF 7912 TRACE
146         ! Y val(2,512)=BOTTOM EDGE OF 7912 TRACE
147         !Y val(N-2,512)=EXTA DIODES THAT ARE ENERGIZED IN THIS VERT. TRACE
150         ! DATA 06 = THE PRESET VALUES FOR DIGITIZER 06
160         ! DATA 07 = THE PRESET VALUES FOR DIGITIZER 07
170         ! DATA QUES = THE QUESTIONS ASKED OF EACH DIGITIZER
171         ! FLAG1 DETERMINES THE PRINT OPTION
172         ! FLAG2 IS AN INTERNALLY SET PRINT FLAG
174     shotnumber=2
175     Pulser$="TEK-109"
176     Pulser vol=50
177     Probe$="HILTECH 91197-1"
178     mtlen=0
180 Data 06:DATA "MODE DIG","DT OFF","GRAT OFF","XYZ ON","MAI 260","GRI 30","FOC
 20","SSW ARM","TV ON","REM OFF",""
190 Data 07:DATA "DT OFF","GRAT OFF","XYZ OFF","MAI 270","GRI 30","FOC 20","SSW
ARM","TV ON","REM OFF","MODE DIG","DIG SSW",""
200 Data ques:DATA "MOD?","DT?","GRAT?","XYZ?","MAI?","GRI?","FOC?","SSW?","TV?"
,"REM?","DFC?","DEP?","VS1?","VU1?","HS1?","HU1?","ID?",""
201 Data stat:DATA 13,70800,70700,0          !ITEMS POLLED BY POLL ALL
210         !  SET UP PROPER LOGICAL UNITS
220     ASSIGN @F7912 TO 70600      !HPIB INTERFACE SELECT CODE FOR MACHINE 6
230     ASSIGN @F7912_6V TO 70601   !CODE FOR MACHINE 6 VERT AMP
240     ASSIGN @F7912_6H TO 70602   !CODE FOR MACHINE 6 HOR AMP
250     ASSIGN @F7912_7 TO 70700    !HPIB INTERFACE SELECT CODE FOR MACHINE 7
260     ASSIGN @F7912_7V TO 70701   !CODE FOR MACHINE 7 VERT AMP
```

```
270     ASSIGN @R7912 7h TO 70702    !CODE FOR MACHINE / HOR GNF
271     ASSIGN @Scope TO 703;FORMAT ON    !7854 SCOPE ADDRESS
272     ENABLE INTR 7;2
273     ON INTR 7 CALL Poll all
274     Num dev=0
275     RESTORE Data stat
277     LOOP      !LOOP TO SET UP POLL ALL
278     Num dev=Num dev+1
279     READ Dev arrav(Num dev)
280     EXIT IF Dev arrav(Num dev)=0
281     END LOOP
282     Num dev=Num dev-1
283     OUTPUT @R7912 6:"ID?";END
290     ENTER @R7912 6;Ident 6$
300     OUTPUT @R7912 7:"ID?";END
310     ENTER @R7912 7;Ident 7$
320 Menu1:                !INTRODUCTORY MENU
330     PRINT TAB(7(1,1)
340     PRINT TAB(10);"7912AD EMI TEST";TAB(50);"DATE: ";DATE$(TIMEDATE)
350     PRINT TABX(10,5);"THIS PROGRAM WILL:"
360     PRINT TAB(15);"--INITIALIZE TWO 7912AD s"
370     PRINT TAB(15);"--SET/READ THE 7912AD SETTINGS"
380     PRINT TAB(15);"--PAUSE FOR TEST                "
390     PRINT TAB(15);"--COMPARE BEFORE TEST TO AFTER TEST 7912 SETTINGS"
400     PRINT TAB(15);"--LIST DEVIATIONS"
410     PRINT TAB(15);"--PLOT BEFORE TEST AND AFTER TEST DATA"
420     PRINT TAB(1)
430     PRINT TAB(15);"THE IDENTIFICATION FOR THE 7912AD s IS:"
440     PRINT TAB(25);"LOGICAL INTERFACE 06 ID IS ";Ident 6$
450     PRINT TAB(25);"LOGICAL INTERFACE 07 ID IS ";Ident 7$
460     PRINT TAB(1)
470     PRINT TAB(1)
480     PRINT CHR$(130);"STOP!!!  SET THE HORIZONTAL SWEEP SPEED TO 10 ns/DIV AND
 PRESS ANY KEY"
490     PRINT CHR$(128)
500     ON KBD GOSUB Init
510     GOTO 510
520     !
530     !-------------------------------------------------------------------------
1000 Init:     !  SET INITIAL DIGITIZER SETTINGS HERE
1001    !-------------------------------------------------------------------------
1002    !
1010    PRINT CHR$(12)    !CLEAR SCREEN
1020    RESTORE Data 06      !SET UP DIGITIZER 06 COMMANDS
1030    Num 06=0
1040    LOOP
1050    Num 06=Num 06+1
1060    READ Io$(Num 06)
1070    EXIT IF Io$(Num 06)=""
1080    END LOOP
1090    RESTORE Data 07      !SET UP DIGITIZER 07 COMMANDS
1100    Num 07=0
1110    LOOP
1120    Num 07=Num 07+1
1130    READ I7$(Num 07)
1140    EXIT IF I7$(Num 07)=""
1150    END LOOP
1160    FOR N=1 TO Num 06-1    !DIGITIZERS COMMANDED HERE
1170    OUTPUT @R7912 6:Io$(N);END
1180    OUTPUT @R7912 7:I7$(N);END
1190    NEXT N
1201    A=1
1210    !
1220    !-------------------------------------------------------------------------
2000                  ! INTERROGATE INITIAL DIGITIZER SETTINGS
2001    !-------------------------------------------------------------------------
```

```
2005    RESTORE Data ques       ! SET UP THE QUESTION MATRIX FOR 7912
2010    Num ques=0
2020    LOOP
2030    Num ques=Num ques+1
2040    READ Q$(Num ques)    !SET UP QUESTIONS
2050    EXIT IF Q$(Num ques)=""
2060    END LOOP
2061    X=1             !PUT DATA IN P(X,25)
2062    Y=3             !PUT DATA IN P(Y,25)
2070    CALL Interrog(@R7912 6,@R7912 7)
2140 Menu2:           !7912 SETUP MENU
2150    PRINT TABXY(5,1);"CHANGES MAY BE MADE TO THE DISPLAYED MENU BY CHANGING T
HE "
2160    PRINT TAB(5);"DATA IN DATA STAMENTS DATA 06 OR DATA 07."
2170    PRINT TAB(1)
2180    PRINT TAB(10);"7912 LOGICAL UNIT 06";TAB(45);"7912 LOGICAL UNIT 07"
2190    PRINT TAB(1)
2200    FOR M=1 TO Num ques-1
2210    PRINT TAB(12);P$(1,M);TAB(47);P$(3,M)
2220    NEXT M
2250    !      DUMP THE DIGITIZER DATA NOW
2251    OUTPUT @R7912 6;"MODE DIG";END
2260    OUTPUT @R7912 6;"DIG SSW";END
2275    OUTPUT @R7912 6;"DUMP RAW";END
2285    ENTER @R7912 6 USING "#,A,W,W,W,W,W":Per$,Byte ,Chzypt,Fstvpt,Lstvpt,Lstdp
t
2295    N=0
2315          ENTER @R7912 6 USING "#,W":C(*)
2330    ENTER @R7912 6 USING "#,B,A":Checsu,Bo$
2387    P=0
2388    !ADD ONE TO THE NEXT TO FOR LOOPS TO CHANGE FOR OPTION BASE ZERO
2389    !INSIDE THE 7912 IS TO OPTION BASE ONE IN 9816
2390    FOR N=Chzypt+1 TO Lstvpt+1
2391          P=P+1
2392          Seq v2(P)=C(N)
2393    NEXT N
2394    U=Lstvpt-Chzvpt
2395    FOR N=Fstvpt+1 TO Chzypt
2397          Q=Q+1
2398          Seq v2(Q)=C(N)
2399    NEXT N
2401    Ctr=1               !COUNTS THE PRESENT VALUE IN THE SEQ v MATRIX
2402    FOR N=1 TO 511
2403          Ptr=2^8*N   !POINTER AT POSITION IN C MATRIX OF X VALUE
2404          IF C(Ptr)=0 THEN Onward2
2405          v_val2(1,N)=Seq v2(Ctr)
2406          Ctr=Ctr+1
2408          IF C(Ptr)=1 THEN Onward2
2409          v_val2(2,N)=Seq v2(Ctr)
2410          Ctr=Ctr+1
2412          IF C(Ptr)=2 THEN Onward2
2413          v_val2(3,N)=Seq v2(Ctr)
2414          Ctr=Ctr+1
2416          IF C(Ptr)=3 THEN Onward2
2417          v_val2(4,N)=Seq v2(Ctr)
2418          Ctr=Ctr+1
2420          IF C(Ptr)=4 THEN Onward2
2421          v_val2(5,N)=Seq v2(Ctr)
2422          Ctr=Ctr+1
2425          IF C(Ptr)>4 THEN
2426                PRINT "TOO MANY Y VALUES";N,C(Ptr),Ptr
2427                GOTO 10000
2428          END IF
2430 Onward2:    !ALL VALUES OF SEQ v HAVE BEEN READ IN FOR THE NUMBER IN B
2431    NEXT N
```

```
2468    !-- ---------------THESE VALUES ARE FOR A FLAT UNLY
2469                        OUTPUT @R7912_6:"VS1?":END
2470                        ENTER @R7912 6:Gra vs1$
2471                           L=LEN(Gra vs1$)
2474                           Gra vs1=VAL(Gra_vs1$[5,L])
2475                        OUTPUT @R7912 6:"VU1?":END
2476                        ENTER @R7912 6:Gra vu1$
2477                           Gra vu1$=Gra vu1$[5,5]
2479                        OUTPUT @R7912 6:"HS1?":END
2480                        ENTER @R7912_6:Gra hs1$
2481                            L=LEN(Gra hs1$)
2482                            Gra hs1=VAL(Gra hs1$[5,L])
2484                        OUTPUT @R7912 6:"HU1?":END
2485                        ENTER @R7912 6:Gra hu1$
2486                           Gra hu1$=Gra hu1$[5,5]
2486    !-----------------------------------------------
2489    Null$=FBD$
2490    ON FBD,5 GOSUB Dig set
2491    PRINT "HIT ANY KEY TO CONTINUE"
2500    GOTO 2500
3000    !
3001    !---- ------------------------------------------------------------------------
3002 Dig set:       ' THE DIGITZER & TEST EQUIP WILL BE SETUP TO ACQUIRE DATA HERE
3008    !-------------------------------------------------------------------------
3009    !
3010 ! OUTPUT @R7912 7:"MOD DIG":END
3020 ! OUTPUT @R7912 7:"SSW ARM":END
3022 ! OUTPUT @R7912 7:"DIG SSW":END
3023 ! OUTPUT @R7912 7:"ATC":END
3025 ! OUTPUT @R7912 7:"REA ATC":END
3026 ! ENTER @R7912 7:Test(*)
3030    'THE PARAMETERS OF THE TEST WILL BE DOCUMENTED HERE
3032    OUTPUT 2:Clear$:
3033    GOTO 3300
3040 Menu3:     'TEST PARAMETER MENU
3050    PRINT TABXY(10,1):"PARAMETERS FOR 7912AD ENT TEST-SHOT NUMBER ":Shotnumbe
r
3051    PRINT TAB(1)
3060    PRINT TABXY(2,3):"PULSER TYPE":TAB(18):Pulser$:TAB(40):"PULSER VOLTAGE ":
TAB(57):Pulser vol
3070    PRINT TAB(2):'PROBE TYPE ":TAB(18):Probe$:TAB(40):"ATTENUATION":TAB(57):A
tten
3080    PRINT TAB(2):"7854 VERTICAL ":TAB(18):Ver set$:TAB(40):"7854 HORIZ ":TAB(
57):Hor set$
3081    PRINT TAB(2)
3082    PRINT TAB(2):"COMMENTS:   ":Comments$
3083    IF Flag1$="SECOND PASS" THEN
3084    GOTO Fire pulser
3085    END IF
3087    ON KEY 1 LABEL "COMMENTS",6 GOTO Comment
3090    ON KEY 5 LABEL "PULSER TYPE",6 GOTO Set pulse
3100    ON KEY 6 LABEL "PULSER LEVEL",6 GOTO Set level
3110    ON KEY 7 LABEL "PROBE TYPE",6 GOTO Set probe
3120    ON KEY 8 LABEL "ATTENUATION",6 GOTO Set atten
3130    ON KEY 9 LABEL "7854 VERT",6 GOTO Set vert
3140    ON KEY 4 LABEL "SHOT NUM",6 GOTO Set hor
3141    ON KEY 0 LABEL "CONTINUE",6 GOTO Print out
3150    GOTO Menu3
3151 Comment:          'INPUT COMMENTS ON TEST SETUP
3152    INPUT "COMMENTS (LIMIT TO 100 CHARACTERS)",Comments$
3153    OUTPUT 2:Clear$
3154    GOTO Menu3
3160 Set pulse:        'INPUT THE TEST PULSER TYPE
3170    INPUT "INPUT THE PULSER TYPE ",Pulser$
3171    OUTPUT 2:Clear$
3180    GOTO Menu3
```

```
3190 Set level:       'INPUT THE PULSER OUPUT VOLTAE
3200    INPUT "INPUT THE PULSER OUTPUT VOLTAGE ",Pulser vol
3210    OUTPUT 2:Clear$
3211    GOTO Menu3
3220 Set probe:       'INPUT THE PROBE TYPE
3230    INPUT "THE MEASUREMENT PROBE IS? ",Probe$
3240    OUTPUT 2:Clear$
3250    GOTO Menu3
3260 Set atten:       'THE ATTENUATION BETWEEN PROBE AND 7854 IS ?
3270    INPUT "THE ATTENUATION BETWEEN THE PROBE AND THE 7854 IS? ",Atten
3280    OUTPUT 2:Clear$
3290    GOTO Menu3
3300 Set vert:        '
3301    PRINT TABXY(1,18);"THE VERTICAL SETTING WILL BE READ AUTOMATICALLY"
3302    OUTPUT @Scope:"VSLL"
3303    OUTPUT @Scope:"SENDX"
3304    ENTER @Scope:Ver set$
3305    OUTPUT @scope:"HSCL"
3307    OUTPUT @Scope:"SENDX"
3308    ENTER @Scope:Hor set$
3310    OUTPUT 2:Clear$
3320    GOTO Menu3
3330 Set hor:         '
3340    PRINT TABXY(1,18);"THE HORIZONTAL SETTING WILL BE READ AUTOMATICALLY"
3350    INPUT "THE SHOT NUMBER IS?",Shotnumber
3360    OUTPUT 2:Clear$
3370    GOTO Menu3
3380 Print out:       'THIS GIVES HARDCOPY
3390    IF Flag1$="PRINT" THEN
3400    PRINTER IS 701
3410    Flag2$="SECOND PASS"
3411    END IF
3412    IF Flag1$ <>"PRINT" THEN
3413    GOTO Fire pulser
3414    END IF
3420    GOTO Menu3
3430    '
3440    '-------------------------------------------------------------------------
3450              'THE COMPUTER WILL BE DISCONNECTED BERFORE FIRING PULSER
3460    '-------------------------------------------------------------------------
3470    '
4000 Fire pulser:     '
4001    Flag2$="FIRST PASS"
4003    PRINTER IS 1
4004    OUTPUT 2:Clear$
4010    PRINT TABXY(5,5);CHR$(130);"STOP";TAB(40);"STOP";TAB(70);"STOP"
4020    PRINT TAB(1)
4025    PRINT CHR$(128)
4030    PRINT TAB(19);"DISCONNECT THE GPIB FROM THE COMPUTER BEFORE FIRING PULSER
."
4031    PRINT TAB(19);"PRESS CONTINUE SOFTKEY AFTER TESTING AND RECONNECTING GPIB
."
4033    ONTIMER 6 CALL "CONTINUE",6 GOTO 4035
4034    GOTO 4034
4035    ' CONTINUE
4045    OUTPUT 2:Clear$
4055    '
4065    '-------------------------------------------------------------------------
5000    'READ THE 7912 SETTINGS AND COMPARE TO STORED SETTINGS
5001    '-------------------------------------------------------------------------
5002    '
5010                          'READ SETTINGS HERE
5011    ! 2           'PUT DATA IN F(X,25)
5012    ! 4           'PUT DATA IN F(Y,25)
5020    CALL Interrog(@F7912 a,@F7912 )
5025    IF Flag1$="PRINT" THEN
```

```
5020    PRINTER IS 701
5027    END IF
5030    PRINT "THE SETTINGS OF THE 7912AD ARE SUMMARIZED BELOW"
5040    PRINT TAB(50)
5050    PRINT TAB(9);"LOGICAL UNIT 06";TAB(49);"LOGICAL UNIT 07"
5051    PRINT TAB(3);"BEFORE";TAB(23);"AFTER";TAB(43);"BEFORE";TAB(63);"AFTER"
5060    PRINT TAB(5)
5070    FOR N=1 TO Num ques-2
5080    PRINT F$(1,N);TAB(20);F$(2,N);TAB(40);F$(3,N);TAB(60);F$(4,N)
5090    NEXT N
5091    PRINT TAB(1)
5100    PRINT F$(2,Num ques-1);TAB(40);F$(4,Num ques-1)
5110    !       DUMP THE DIGITIZER DATA NOW
5120  OUTPUT @R7912_6;"DUMP RAW";END
5140  ENTER @R7912_6 USING "#,A,W,W,W,W,W";Perc$,Byte_c,Chzvptr,Fstvptr,Lstvptr,
Lstdptr
5150  N=0
5160        ENTER @R 7912_6 USING "#,W";B(*)
5170  ENTER @R791_ 6 USING "#,B,A";Checsum,Box$
5200  PRINT TAB(5)
5209  PRINT TIME$(TIMEDATE)
5210  PRINT DATE$(TIMEDATE)
5218  PRINT "THE RAW DATA MEMORY POINTERS ARE:";TAB(60);"BEFORE";TAB(70);"AFTER"
5228  PRINT TAB(5)
5240  PRINT TAB(2);"THE BYTE COUNT IS ";TAB(60);Byte_c;TAB(70);Byte
5241  PRINT TAB(2);"FIRST DATA VALUE STORED DURING LEFT VERT SCAN ";TAB(60);Chzv
ptr;TAB(70);Chzvptr
5243  PRINT TAB(2);"FIRST VALID WORD IN THE Y DATA ARRAY";TAB(60);Fstvpt;TAB(70)
;Fstvptr
5244  PRINT TAB(2);"LAST VALID WORD IN THE Y ARRAY ";TAB(60);Lstvpt;TAB(70);Lsty
ptr
5245  PRINT TAB(2);"ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY ";TAB(60);L
stdpt;TAB(70);Lstdptr
5246  PRINT TAB(2);"THE CHECKSUM WAS";TAB(60);Checsu;TAB(70);Checsum
5247  PRINT TAB(2);"THE SEMICOLON IS PRINTED IF RECEIVED";TAB(60);Bo$;TAB(70);Bo
x$
5250  P=0
5251  !ADD ONE TO THE NEXT TO FOR LOOPS TO CHANGE FOR OPTION BASE ZERO
5252  !INSIDE THE 7912 S TO OPTION BASE ONE IN 9816
5253  FOR N=Chzvptr+1 TO Lstvptr+1
5254        P=P+1
5255        Seq_v(P)=B(N)
5256  NEXT N
5257  U=Lstvptr-Chzvptr
5258  FOR N=Lstvptr+1 TO Chzvptr
5260        U=U+1
5261        Seq_v(U)=B(N)
5262  NEXT N
5264  Ctr=1               !COUNTS THE PRESENT VALUE IN THE SEQ_V MATRIX
5265  FOR N=1 TO 511
5266        Ptr=255*N+N   !POINTER AT POSITION IN B MATRIX OF X VALUE
5267        IF B(Ptr)=0 THEN Onward
5268        r_val(1,N)=Seq_v(Ctr)
5269        Ctr=Ctr+1
5271        IF B(Ptr)=1 THEN Onward
5272        r_val(2,N)=Seq_v(Ctr)
5273        Ctr=Ctr+1
5275        IF B(Ptr)=2 THEN Onward
5276        r_val(3,N)=Seq_v(Ctr)
5277        Ctr=Ctr+1
5278        IF B(Ptr)=3 THEN Onward
5280        r_val(4,N)=Seq_v(Ctr)
5281        Ctr=Ctr+1
5283        IF B(Ptr)=4 THEN Onward
5284        r_val(5,N)=Seq_v(Ctr)
5285        Ctr=Ctr+1
```

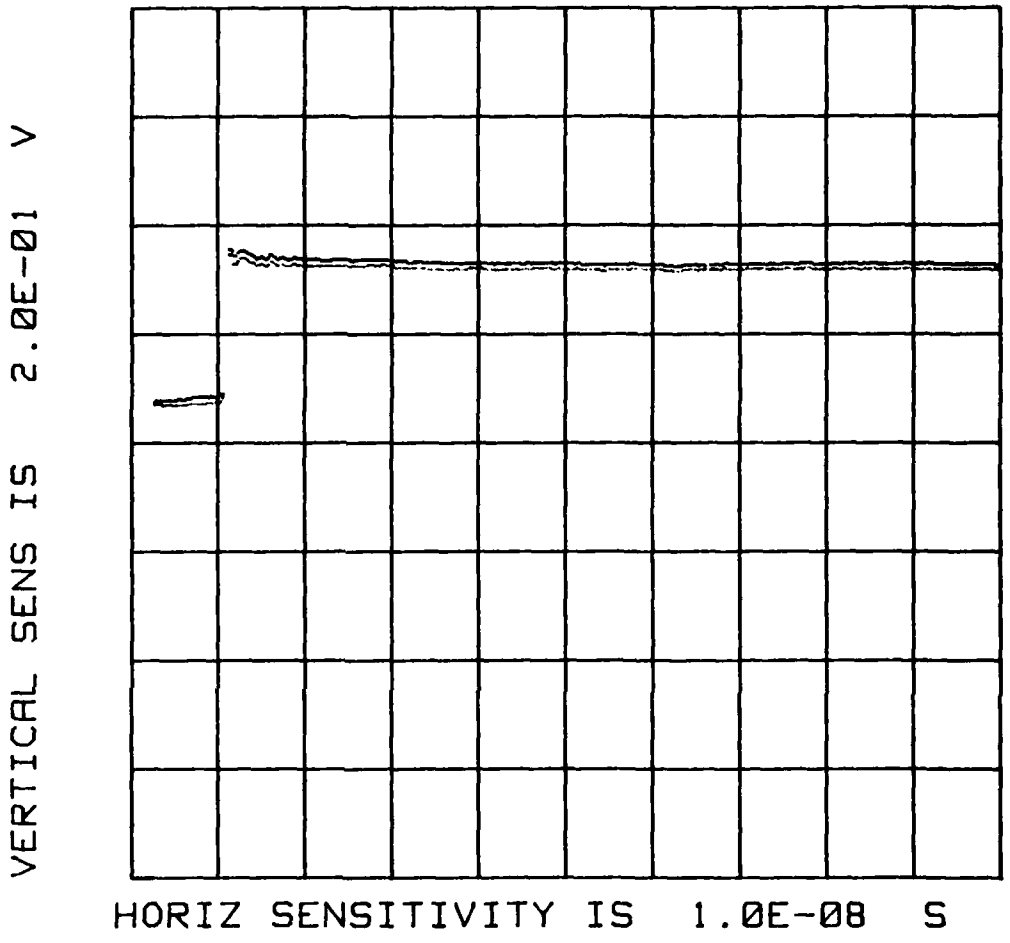
```
5288        IF B(Ptr)>4 THEN
5289              PRINT "TOO MANY Y VALUES";N,B(Ptr),Ptr
5290              GOTO 10000
5291        END IF
5293 Onward:    !ALL VALUES OF SEQ # HAVE BEEN READ IN FOR THE NUMBER IN B
5294  NEXT N
6000  !
6010  !-------------------------------------------------------------------------
6020                !THE BEFORE AND AFTER RAW DATA IS COMPARED HERE
6030  !-------------------------------------------------------------------------
6040  !
6041  Top_err=0
6042  Bot_err=0
6043  Ex1_err=0
6044  Ex2_err=0
6050  FOR N=1 TO 512
6060  IF Y_val1(1,N)<>Y_val2(1,N) THEN Top_err=Top_err+1
6070  IF Y_val1(2,N)<>Y_val2(2,N) THEN Bot_err=Bot_err+1
6080  IF Y_val1(3,N)<>Y_val2(3,N) THEN Ex1_err=Ex1_err+1
6090  IF Y_val1(4,N)<>Y_val2(4,N) THEN Ex2_err=Ex2_err+1
6100  NEXT N
6110  PRINT TAB(2);"THE RAW DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED"
6120  PRINT TAB(2);"THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE ";Top_err
6130  PRINT TAB(2);"THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE ";Bot_err
6140  PRINT TAB(2);"THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE ";Ex2_err
6150  WAIT 5
7000  !
7001  !-------------------------------------------------------------------------
7002                !PLOT THE BEFORE AND AFTER RAW DATA HERE
7004  !-------------------------------------------------------------------------
7005  !
7009 Plot_data:      !PLOT THE DATA HERE
7010  PRINT CHR$(12)    !CLEAR SCREEN
7012 Draw_data:   !PLOT IT HERE
7013  PLOTTER IS 705,"HPGL"
7016  GCLEAR
7017  GRAPHICS ON
7018  PEN 1
7019  DEG
7020  VIEWPORT 50,1.0*.30,100
7021  WINDOW 0,512,0,512
7022  FRAME
7023  FOR N=1 TO 7
7024  MOVE 51.2*N,0
7025  DRAW 51.2*N,512
7026  NEXT N
7027  FOR N=1 TO 7
7028  MOVE 0,64*N
7029  DRAW 512,64*N
7030  NEXT N
7031  FOR I=1 TO 512
7032  MOVE I,Y_val1(1,I)
7033  DRAW I,Y_val1(1,I)
7034  NEXT I
7035  PEN 2
7037  FOR I=1 TO 512
7038  MOVE I,Y_val2(2,I)
7040  DRAW I,Y_val2(2,I)
7041  NEXT I
7046  CLIP OFF
7047  MOVE -270,-150
7048  PEN 3
7049  LABEL "7912HD RAW MEMORY DUMP FOR EMI TEST"
7050  MOVE -10,-35
7051  CSIZE 3.5
7052  LABEL USING "K,2X,D.DE,2X,K";"HORIZ SENSITIVITY IS",Gra_hsl,Gra_hsl$
```

```
7054  MOVE -50,0
7055  LDIR 90
7057  LABEL USING "K,2X,D.DE,2X,K";"VERTICAL SENS IS ",Gra_vs1,Gra_vu1$
7058  LDIR 0
7059  MOVE -190,-100
7060  CSIZE 5,.6
7062  LABEL "SHOT NUMBER",Shotnumber
7063  PRINTER IS 1
10000  END
20000  SUB Poll_all(OPTIONAL Dev)
20010       INTEGER I
20020       COM /Bus/ Dev_array(*),INTEGER Num_dev,Status_byte(*)
20030       ON TIMEOUT 7,.5 GOSUB No_response
20040       SELECT NPAR
20050       CASE 1
20060            I=0
20070            LOOP
20080                 I=I+1
20090            EXIT IF Dev=Dev_array(I)
20100            END LOOP
20110            Status_byte(I)=SPOLL(Dev)
20120            SUBEXIT
20130       CASE 0
20140            FOR I=1 TO Num_dev
20150                 IF Status_byte(I)=0 THEN
20160                      Status_byte(I)=SPOLL(Dev_array(I))
20170                 END IF
20180            NEXT I
20190            STATUS 7,7;I
20200            IF BIT(I,10) THEN
20210                 FOR I=1 TO Num_dev
20220                      IF Status_byte(I)<0 THEN
20230                           Status_byte(I)=SPOLL(Dev_array(I))
20240                      END IF
20250                 NEXT I
20260                 STATUS 7,7;I
20270                 IF BIT(I,10) THEN
20280                      PRINT CHR$(12)
20290                      BEEP
20300                      PRINT
20310                      PRINT " FATAL BUS ERROR"
20320                      PRINT
20330                      PRINT "DEVICE NOT RESPONDING"
20340                      STOP
20350                 END IF
20360            END IF
20370       END SELECT
20380       OFF TIMEOUT
20390       ENABLE INTR 7
20400       SUBEXIT
20410 No_response:Status_byte(I)=-1
20420       RETURN
20430  SUBEND
22000  SUB Interrogate(@R7912 a,@R7912 b)
22100  COM /Int/ D$(*),P$(*),Num_ques,X,Y
23000  !  INTERROGATE DIGITIZER SETTINGS HERE
23080  FOR P=1 TO Num_ques-1
23090  OUTPUT @R7912 a:D$(P);END
23100  ENTER @R7912 b:P$(X,P)
23110  OUTPUT @R7912 7:D$(P);END
23120  ENTER @R7912 7:P$(Y,P)
23130  NEXT P
23140  SUBEND
```

APPENDIX C
COMPUTER PRINTOUTS AND PLOTS

The accompanying printouts and plots are of the various types of testing and of the data recovered from each test. There are no errors in any of the printouts or plots since the 7912AD was not disrupted by any of the pulses or power losses.

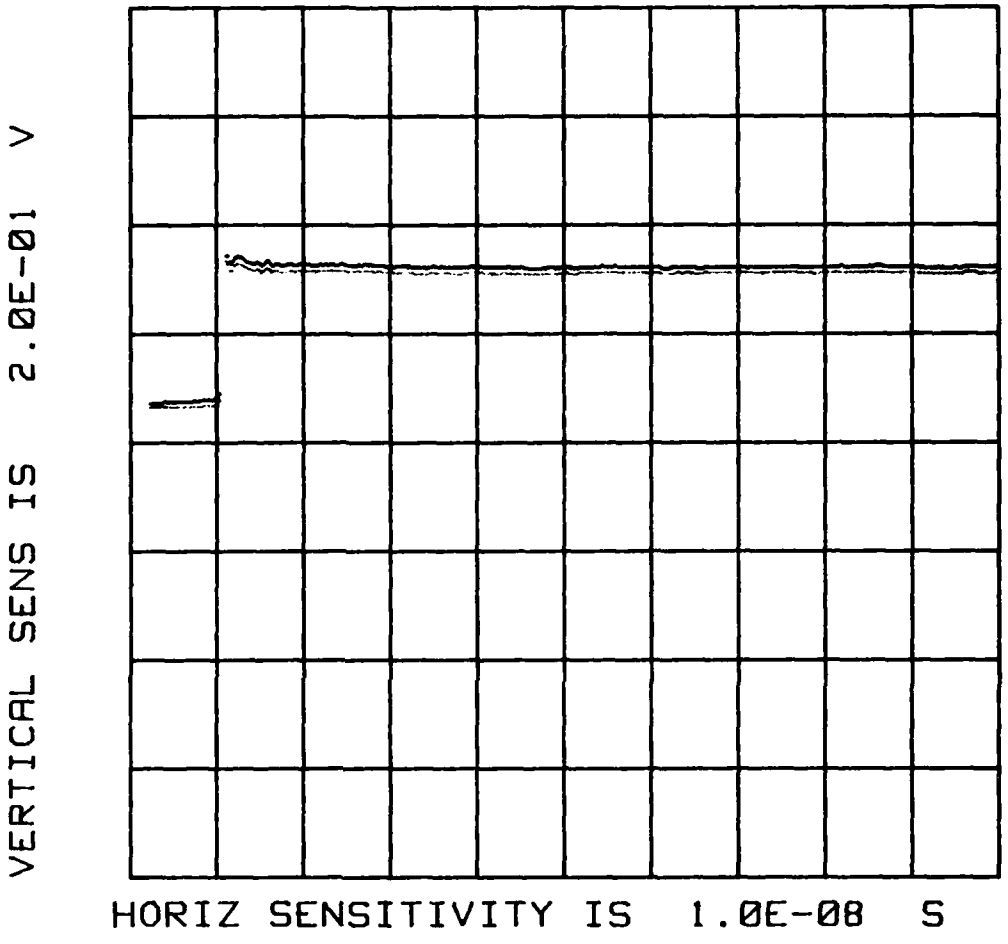
```
 ARMETERS FOR 7912AD EMI TEST-SHOT NUMBER  2000

PULSER TYPE        SPIRE SPI-25          PULSER VOLTAGE     100
 PROBE TYPE        AILTECH 91197-1       ATTENUATION        0
 7854 VERTICAL     20E-03                7854 HORIZ         5E-09

 COMMENTS:  This is the first attempt to drive the braid of the cable direc
tly.
THE SETTINGS OF THE 7912AD ARE SUMMARIZED BELOW

        LOGICAL UNIT 06                          LOGICAL UNIT 07
  BEFORE                  AFTER          BEFORE                  AFTER

MODE DIG:               MODE DIG:       MODE DIG:               MODE TV:
DT OFF:                 DT OFF:         DT OFF:                 DT OFF:
GRAT OFF:               GRAT OFF:       GRAT OFF:               GRAT OFF:
XYZ ON:                 XYZ RAW:        XYZ OFF:                XYZ OFF:
MAI 260:                MAI 260:        MAI 270:                MAI 270:
GRI 30:                 GRI 30:         GRI 30:                 GRI 30:
FOC 20:                 FOC 20:         FOC 20:                 FOC 20:
SSW DIS:                SSW DIS:        SSW NSS:                SSW NSS:
TV ON:                  TV ON:          TV ON:                  TV ON:
REM OFF:                REM OFF:        REM OFF:                REM OFF:
OPC OFF:                OPC OFF:        OPC OFF:                OPC OFF:
DEF OFF:                DEF OFF:        DEF OFF:                DEF OFF:
VS1 +200.E-03;          VS1 +200.E-03;  VS1 +200.E-03;          VS1 +200.E-03;
VU1 V;                  VU1 V;          VU1 V;                  VU1 V;
HS1 +10.E-09;           HS1 +10.E-09;   HS1 +10.E-09;           HS1 +10.E-09;
HU1 S;                  HU1 S;          HU1 S;                  HU1 S;

ID TEK/7912AD.V7.1.F2.1;                ID TEK/7912AD.V7.1.F2.1;

07:50:05
 4 Jan 1985
THE RAW DATA MEMORY POINTERS ARE:                                  BEFORE     AFTER

 THE BYTE COUNT IS                                                  8201       8201
 FIRST DATA VALUE STORED DURING LEFT VERT SCAN                      344        344
 FIRST VALID WORD IN THE Y DATA ARRAY                               0          0
 LAST VALID WORD IN THE Y ARRAY                                     988        988
 ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY                   3583       3583
 THE CHECKSUM WAS                                                  210        210
 THE SEMICOLON IS PRINTED IF RECEIVED                              ;          ;
 THE RAW DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED
 THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE  0
 THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE  0
 THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE  0
```



SHOT NUMBER 2000

7912AD RAW MEMORY DUMP FOR EMI TEST

```
PARAMETERS FOR 7912AD EMI TEST-SHOT NUMBER  2006

PULSER TYPE        SPIRE SPI-25          PULSER VOLTAGE     1400
 PROBE TYPE        AILTECH 91197-1       ATTENUATION        0
 7854 VERTICAL     20E-03                7854 HORIZ         5E-09

 COMMENTS:  This is the final attempt to drive between the braid and the sc
rew o
n the GPIB connector.
THE SETTINGS OF THE 7912AD ARE SUMMARIZED BELOW

        LOGICAL UNIT 06                          LOGICAL UNIT 07
  BEFORE                AFTER              BEFORE                AFTER

MODE DIG:             MODE DIG:          MODE DIG:             MODE DIG:
DT OFF:               DT OFF:            DT OFF:               DT OFF:
GRAT OFF:             GRAT OFF:          GRAT OFF:             GRAT OFF:
XYZ ON:               XYZ RAW:           XYZ OFF:              XYZ OFF:
MAI 260:              MAI 260:           MAI 270:              MAI 270:
GRI 30:               GRI 30:            GRI 30:               GRI 30:
FOC 20:               FOC 20:            FOC 20:               FOC 20:
SSW DIS:              SSW DIS:           SSW NSS:              SSW NSS:
TV ON:                TV ON:             TV ON:                TV ON:
REM OFF:              REM OFF:           REM OFF:              REM OFF:
OPC OFF:              OPC OFF:           OPC OFF:              OPC OFF:
DEF OFF:              DEF OFF:           DEF OFF:              DEF OFF:
VS1 +200.E-03;        VS1 +200.E-03;     VS1 +200.E-03;        VS1 +200.E-03;
VU1 V;                VU1 V;             VU1 V;                VU1 V;
HS1 +10.E-09;         HS1 +10.E-09;      HS1 +10.E-09;         HS1 +10.E-09;
HU1 S;                HU1 S;             HU1 S;                HU1 S;

ID TEK/7912AD,V??.1,F2.1;             ID TEK/7912AD,V??.1,F2.1;

11:57:17
 4 Jan 1985
THE RAW DATA MEMORY POINTERS ARE:                                BEFORE     AFTER

 THE BYTE COUNT IS                                               8201       8201
 FIRST DATA VALUE STORED DURING LEFT VERT SCAN                   0          0
 FIRST VALID WORD IN THE Y DATA ARRAY                            0          0
 LAST VALID WORD IN THE Y ARRAY                                  996        996
 ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY                3583       3583
 THE CHECKSUM WAS                                                22         22
 THE SEMICOLON IS PRINTED IF RECEIVED                            ;          ;
 THE RAW DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED
 THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE  0
 THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE  0
 THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE  0
```



SHOT NUMBER 2006

7912AD RAW MEMORY DUMP FOR EMI TEST

PARAMETER [illegible] FOR [illegible]

[illegible]	[illegible]	POWER VOLTAGE	250
PULSE TYPE	[illegible]	ATTENUATION	0
[illegible]	[illegible]	7854 MOD/Z	5E-09

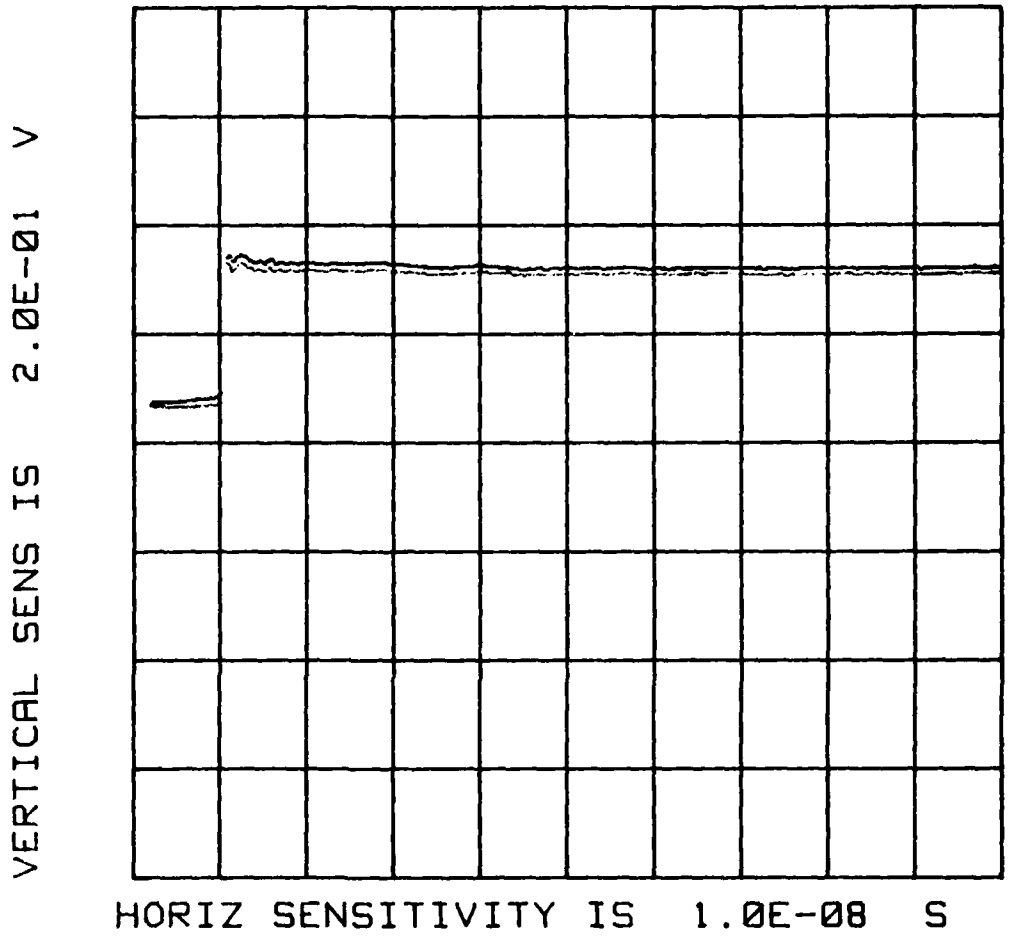
COMMENTS: This is the second in a series of attempts to pulse the power line. THE SETTINGS OF THE 7470A ARE SUMMARIZED BELOW

LOGICAL UNIT 06		LOGICAL UNIT 07	
BEFORE	AFTER	BEFORE	AFTER
MODE DIG;	MODE DIG;	MODE DIG;	MODE IV;
DT OFF;	DT OFF;	DT OFF;	DT OFF;
GRAT OFF;	GRAT OFF;	GRAT OFF;	GRAT OFF;
XYZ ON;	XYZ RAW;	XYZ OFF;	XYZ OFF;
MAI 260;	MAI 260;	MAI 270;	MAI 270;
GRI 30;	GRI 30;	GRI 30;	GRI 30;
FOC 20;	FOC 20;	FOC 20;	FOC 20;
SSW DIS;	SSW DIS;	SSW NSS;	SSW NSS;
IV ON;	IV ON;	IV ON;	IV ON;
REM OFF;	REM OFF;	REM OFF;	REM OFF;
OPC OFF;	OPC OFF;	OPC OFF;	OPC OFF;
DEF OFF;	DEF OFF;	DEF OFF;	DEF OFF;
VSI +200.E-03;	VSI +200.E-03;	VSI +200.E-03;	VSI +200.E-03;
VUI V;	VUI V;	VUI V;	VUI V;
HSI +10.E-09;	HSI +10.E-09;	HSI +10.E-09;	HSI +10E-09;
HUI S;	HUI S;	HUI S;	HUI S;
ID TEK/7470A,V7.1,F2.1;		ID TEK/7470A,V7.1,F2.1;	

01:20:05
 Y JAN 1985
T-F RAW DATA MEMORY POINTERS ARE:

	BEFORE	AFTER
THE BYTE COUNT IS	8201	8201
FIRST DATA VALUE STORED [illegible]	562	562
FIRST VALID WORD IN THE [illegible]	0	0
LAST VALID WORD IN THE [illegible]	960	960
ONE CONNECTS ABOVE LAST [illegible]	3563	3563
THE [illegible] WAS	37	37
THE [illegible]	;	;

IS [illegible]
THE [illegible]
THE [illegible]
THE [illegible]



SHOT NUMBER 3001

7912AD RAW MEMORY DUMP FOR EMI TEST

PARAMETERS FOR 7912AD EMI TEST-SHOT NUMBER 3004

PULSER TYPE	SPIRE SPI-25	PULSER VOLTAGE	1400
PROBE TYPE	AILTECH 91197-1	ATTENUATION	0
7854 VERTICAL	20E-03	785 HORIZ	5E-09

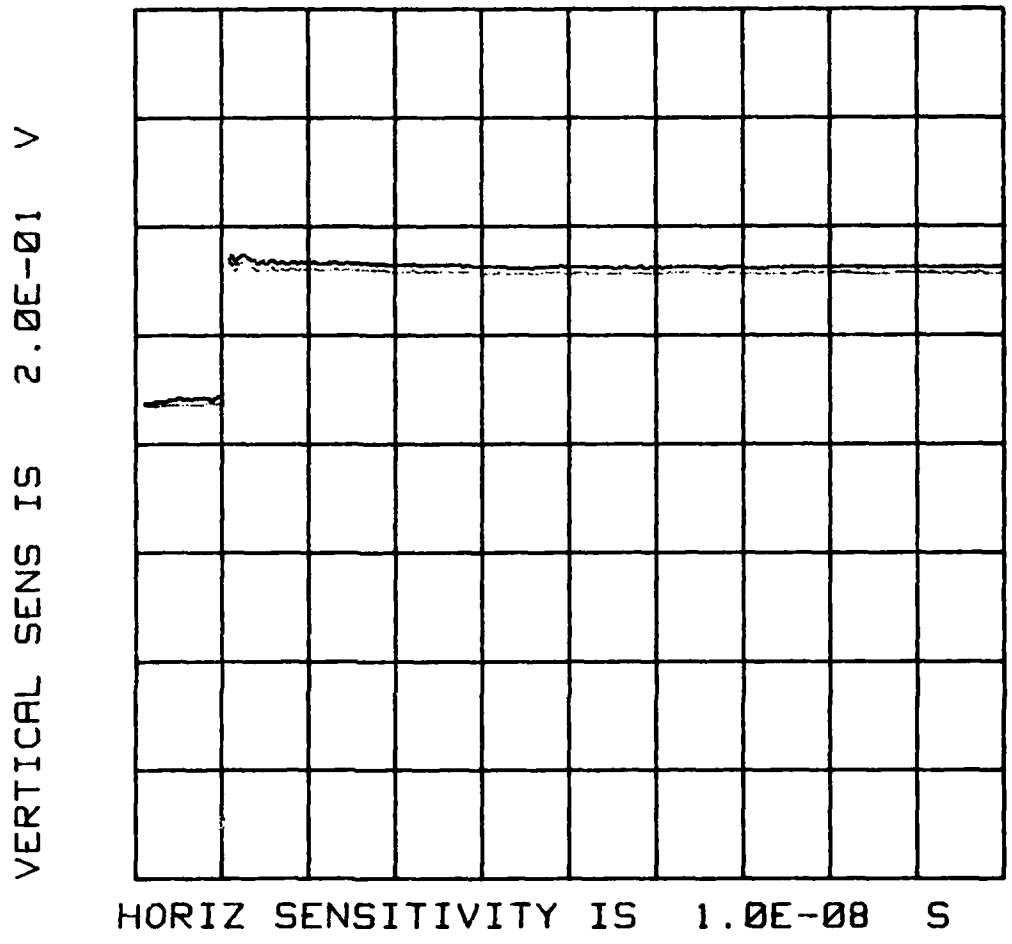
COMMENTS: This attempt is with the 11.5 inch foil and the other connector is o
n the tan grid.
THE SETTINGS OF THE 7912AD ARE SUMMARIZED BELOW

LOGICAL UNIT 06		LOGICAL UNIT 07	
BEFORE	AFTER	BEFORE	AFTER
MODE DIG;	MODE DIG;	MODE DIG;	MODE TV;
DT OFF;	DT OFF;	DT OFF;	DT OFF;
GRAT OFF;	GRAT OFF;	GRAT OFF;	GRAT OFF;
XYZ ON;	XYZ RAW;	XYZ OFF;	XYZ OFF;
MAI 260;	MAI 260;	MAI 270;	MAI 270;
GRI 30;	GRI 30;	GRI 30;	GRI 30;
FOC 20;	FOC 20;	FOC 20;	FOC 20;
SSW DIS;	SSW DIS;	SSW NSS;	SSW NSS;
TV ON;	TV ON;	TV ON;	TV ON;
REM OFF;	REM OFF;	REM OFF;	REM OFF;
OPC OFF;	OPC OFF;	OPC OFF;	OPC OFF;
DEF OFF;	DEF OFF;	DEF OFF;	DEF OFF;
VS1 +200.E-03;	VS1 +200.E-03;	VS1 +200.E-03;	VS1 +200.E-03;
VU1 V;	VU1 V;	VU1 V;	VU1 V;
HS1 +10.E-09;	HS1 +10.E-09;	HS1 +10.E-09;	HS1 +10.E-09;
HU1 S;	HU1 S;	HU1 S;	HU1 S;
ID TEK/7912AD,V77.1,F2.1;		ID TEK/7912AD,V77.1,F2.1;	

02:34:26
9 Jan 1985

THE RAW DATA MEMORY POINTERS ARE:	BEFORE	AFTER
THE BYTE COUNT IS	8201	8201
FIRST DATA VALUE STORED DURING LEFT VERT SCAN	926	926
FIRST VALID WORD IN THE Y DATA ARRAY	0	0
LAST VALID WORD IN THE Y ARRAY	1004	1004
ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY	3583	3583
THE CHECK SUM WAS	210	210
THE SEMICOLON IS PRINTED IF RECEIVED	;	;

THE RAW DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED
THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE 0



SHOT NUMBER 3004

7912AD RAW MEMORY DUMP FOR EMI TEST

PARAMETERS FOR 7912HD EM1 TEST-SHOT NUMBER 4015

PULSER TYPE	SPIRE SPI-25	PULSER VOLTAGE	0
PROBE TYPE	MILTECH 91197-1	ATTENUATION	0
7854 VERTICAL	1	7854 HORIZ	50E-03

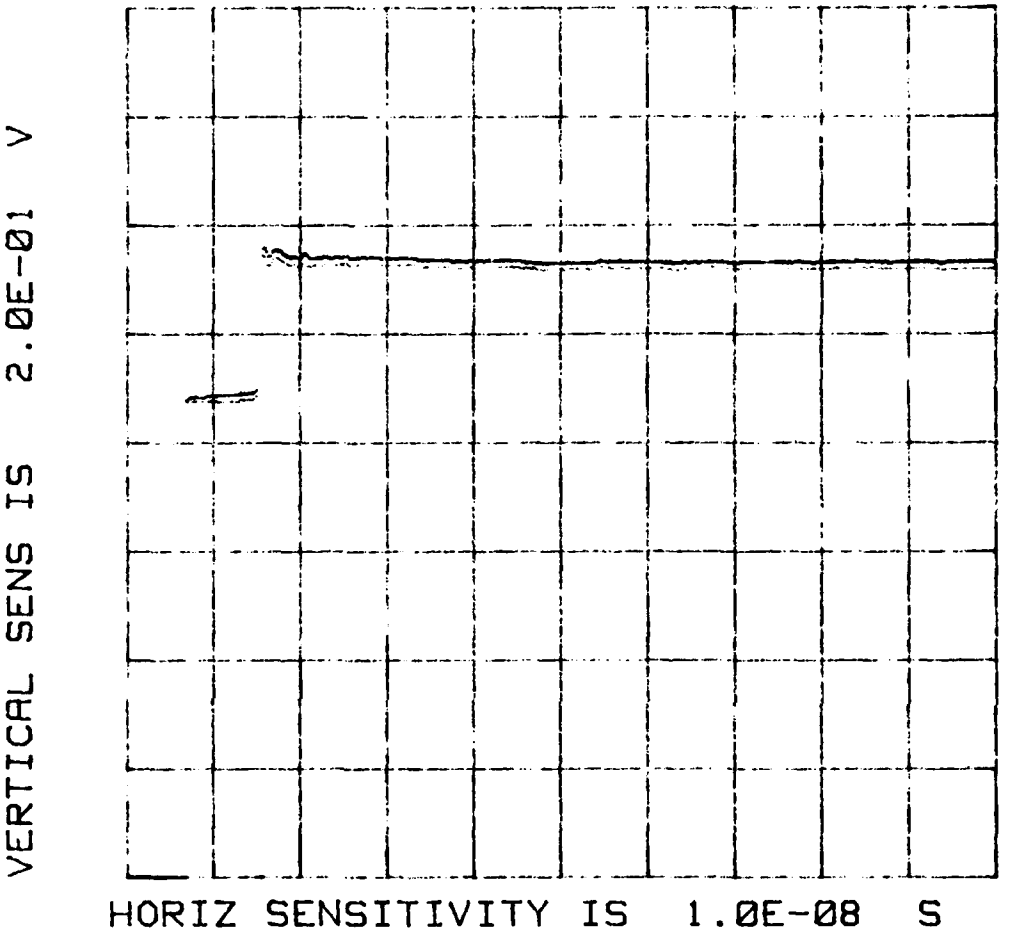
COMMENTS: This is an attempt to interrupt the power for approximately 100 ms.
THE SETTINGS OF THE 7912HD ARE SUMMARIZED BELOW

LOGICAL UNIT 06		LOGICAL UNIT 07	
BEFORE	AFTER	BEFORE	AFTER
MODE D16:	MODE D16:	MODE D16:	MODE D16:
DT OFF:	DT OFF:	DT OFF:	DT OFF:
GRAT OFF:	GRAT OFF:	GRAT OFF:	GRAT OFF:
XYZ ON:	XYZ RAW:	XYZ OFF:	XYZ OFF:
MA1 260:	MA1 260:	MA1 270:	MA1 270:
GRI 30:	GRI 30:	GRI 30:	GRI 30:
FOC 20:	FOC 20:	FOC 20:	FOC 20:
SSW D1S:	SSW D1S:	SSW NSS:	SSW NSS:
TV ON:	TV ON:	TV ON:	TV ON:
REM OFF:	REM OFF:	REM OFF:	REM OFF:
OPC OFF:	OPC OFF:	OPC OFF:	OPC OFF:
DEF OFF:	DEF OFF:	DEF OFF:	DEF OFF:
VS1 +200.E-03:	VS1 +200.E-03:	VS1 +200.E-03:	VS1 +200.E-03:
VU1 V:	VU1 V:	VU1 V:	VU1 V:
HS1 +10.E-09:	HS1 +10.E-09:	HS1 +10.E-09:	HS1 +10.E-09:
HU1 S:	HU1 S:	HU1 S:	HU1 S:
ID TEK/7912HD.V77.1.F2.1:		ID TEK/7912HD.V77.1.F2.1:	

09:50:37
10 Jan 1985

THE RAM DATA MEMORY POINTERS ARE:	BEFORE	AFTER
THE BYTE COUNT IS	8201	8201
FIRST DATA VALUE STORED DURING LEFT VERT SCAN	552	552
FIRST VALID WORD IN THE Y DATA ARRAY	0	0
LAST VALID WORD IN THE Y ARRAY	948	948
ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY	3583	3583
THE CHECKSUM WAS	224	224
THE SETUPCOUNT IS PRINTED IF RECEIVED	:	:

THE RAM DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED
THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE 0



SHOT NUMBER 4013

7912AD RAW MEMORY DUMP FOR EMI TEST

PARAMETERS FOR 7912AD EMI TEST--SHOT NUMBER 5000

PULSER TYPE	SPIRE SPI-25	PULSER VOLTAGE	1400
PROBE TYPE	AILTECH 91197-1	ATTENUATION	0
7854 VERTICAL	20E-03	7854 HORIZ	5E-09

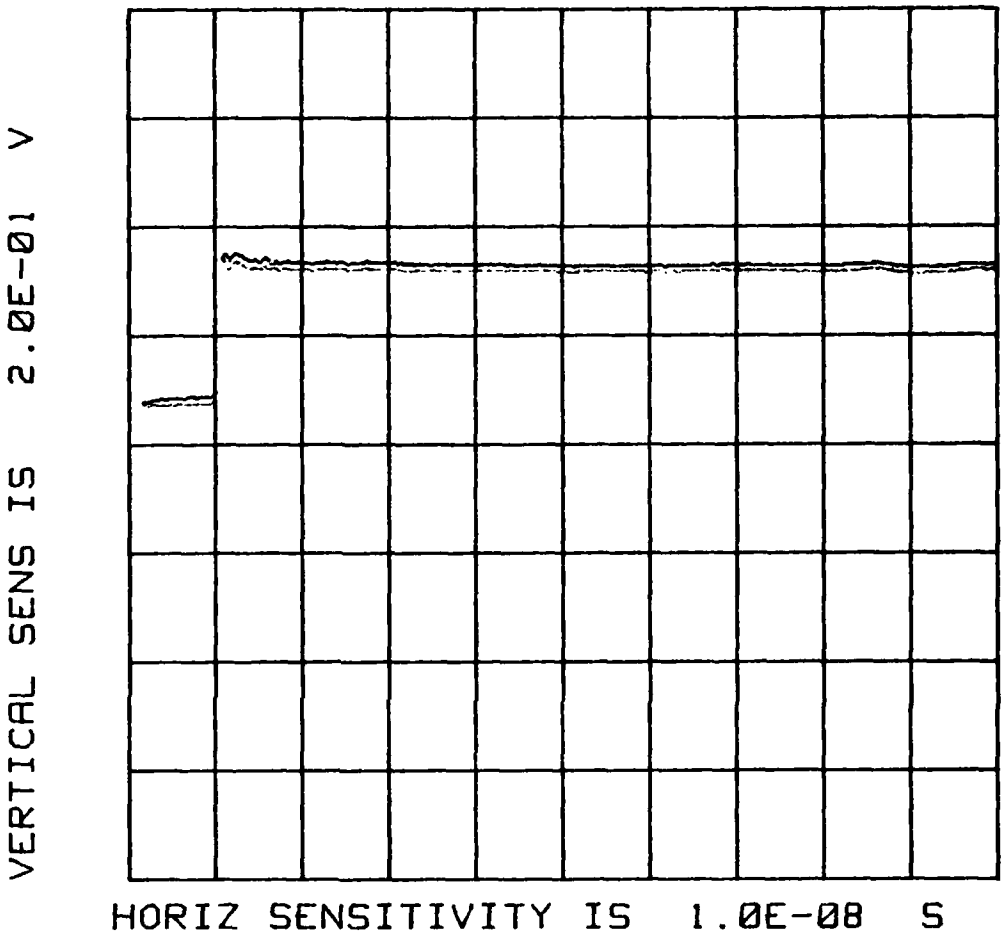
COMMENTS: This is an attempt to pulse the 7912 from front to back with a 1400
volt pulse.
THE SETTINGS OF THE 7912AD ARE SUMMARIZED BELOW

LOGICAL UNIT 06		LOGICAL UNIT 07	
BEFORE	AFTER	BEFORE	AFTER
MODE DIG;	MODE DIG;	MODE DIG;	MODE DIG;
DT OFF;	DT OFF;	DT OFF;	DT OFF;
GRAT OFF;	GRAT OFF;	GRAT OFF;	GRAT OFF;
XYZ ON;	XYZ RAW;	XYZ OFF;	XYZ OFF;
MAI 260;	MAI 260;	MAI 270;	MAI 270;
GRI 30;	GRI 30;	GRI 30;	GRI 30;
FOC 20;	FOC 20;	FOC 20;	FOC 20;
SSW DIS;	SSW DIS;	SSW NSS;	SSW NSS;
TV ON;	TV ON;	TV ON;	TV ON;
REM OFF;	REM OFF;	REM OFF;	REM OFF;
OPC OFF;	OPC OFF;	OPC OFF;	OPC OFF;
DEF OFF;	DEF OFF;	DEF OFF;	DEF OFF;
VS1 +200.E-03;	VS1 +200.E-03;	VS1 +200.E-03;	VS1 +200.E-03;
VU1 V;	VU1 V;	VU1 V;	VU1 V;
HS1 +10.E-09;	HS1 +10.E-09;	HS1 +10.E-09;	HS1 +10.E-09;
HU1 S;	HU1 S;	HU1 S;	HU1 S;
ID TEK/7912AD,V77.1,F2.1;		ID TEK/7912AD,V77.1,F2.1;	

02:53:17
9 Jan 1985

THE RAW DATA MEMORY POINTERS ARE:	BEFORE	AFTER
THE BYTE COUNT IS	8201	8201
FIRST DATA VALUE STORED DURING LEFT VERT SCAN	852	852
FIRST VALID WORD IN THE Y DATA ARRAY	0	0
LAST VALID WORD IN THE Y ARRAY	1000	1000
ONE ADDRESS ABOVE LAST ELEMENT IN DEFFECTS ARRAY	3583	3583
THE CHECKSUM WAS	90	90
THE SEMICOLON IS PRINTED IF RECEIVED	;	;

THE RAW DATA BEFORE AND AFTER THE SHOT HAS BEEN COMPARED
THE NUMBER OF ERRORS IN THE TOP EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE BOT EDGE DATA ARE 0
THE NUMBER OF ERRORS IN THE 2ND EXTRA DIODE ARE 0

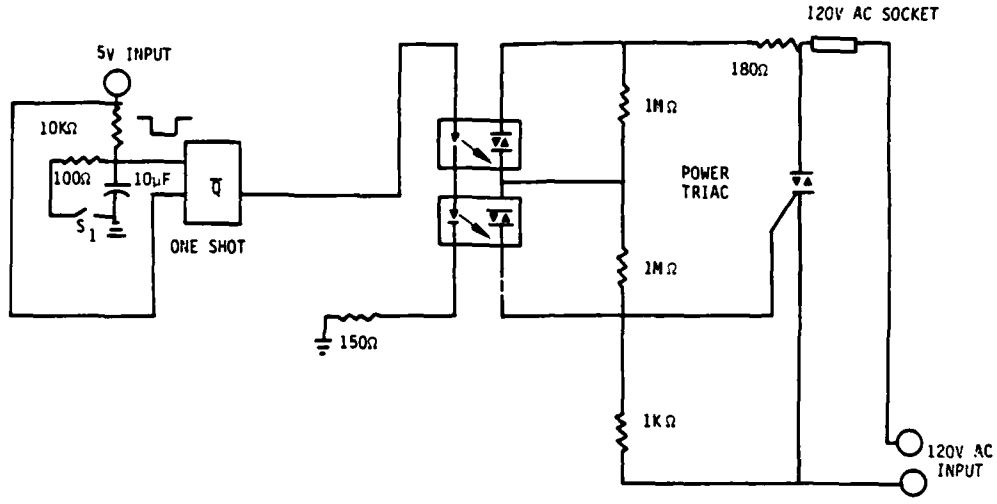


SHOT NUMBER 5000

7912AD RAW MEMORY DUMP FOR EMI TEST

APPENDIX D
POWER INTERRUPTION DEVICE

Since a brief power interruption is desired for testing, the following device was constructed:



When S_1 is closed and reopened, it discharges the capacitor to provide a negative pulse to the one-shot integrated circuit. This pulls the $\overline{Q}$ output low for a time period set by the timing resistor and capacitor which turns off the light emitting diodes in the optocouplers. While off, power is interrupted to the output and once the one-shot times out, power is restored.

APPENDIX E
DESCRIPTION OF SERIES AND SHOT NUMBERS

SERIES	TYPE OF TEST
2000	Pulse Injection on GPIB Cable
3000	Pulse Injection on Power Line
4000	Power Interruption
5000	Pulse Injection on Chassis

SHOT NUMBER	MEASURED CURRENT IN PULSE
2000	1.3A
2006	21.8A
3001	1.8A
3004	12.8A
4013	does not apply (101ms of power interruption)
5000	28.8A

APPENDIX F
SELECTED BIBLIOGRAPHY

1. 7912AD Programmable Digitizer Operators Instruction Manual, 1979, Tektronix (no author's name), Revised Edition, May 1981.

2. 7912AD Programmable Digitizer Service Volumes 1 and 2 Instruction Manuals, 1979 Tektronix (no author's name), Revised Edition, January 1983.

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